

# **Orientation Programme on Psycholinguistics with Special Reference to Language and Science Teaching**

**( 7.1.1991 to 11.1.1991 )**

**— a report**

**Prof. Biswanath Roy  
Hony. Programme Director**



**National Council of Educational Research and Training  
Office of the Field Adviser**

**( West Bengal, Sikkim, Andaman & Nicobar Islands )  
P-23, C. I. T. ROAD, SCHEME-55, CALCUTTA-700 014  
1991**



"Ideas that proved useful for ordering things easily get such an authority over us that we forget their worldly origin and take them as unalterably given. They are then labelled "logically necessary", "a priori given", etc. The road of scientific advance is made impassable for a long time by such misconception. It is therefore not for the fun of it that we try to analyse long familiar ideas and demonstrate the circumstances on which their title and unimpeachability depend and how, as minute inquiry shows, they grow from the data of experience. It is by this means that their all too great authority is broken. They must be rejected if they cannot really be legitimised and corrected, if their connection with the given facts has been all too carelessly replaced by another, and if a new system has been built that we prefer on some other grounds".

Albert Einstein : Ernst Mach. Physikalische Zeitschrift, 1916, 17(7), 102.



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PREFACE

The Orientation programme on psycholinguistics with special reference to language and science teaching was approved by the Council and revalidated as per the letter No.F.23/89-Prog./497 dt.23/30.10.90.

In continuation of the approval and revalidation order, the programme was organised from 7.1.91 to 11.1.91 by the FA's Office as it's own programme. The venue was also the FA's office.

The programme was inaugurated on 7.1.91 at about 11 A.M. by Prof. P.K. Chowdhury, DPI and Ex-officio Secretary (Hr. Edn.), Govt. of West Bengal and also Chairman of the PAC of the FA's office.

The programme was participated by 24 (twentyfour) participants drawn from both B.Ed. and general colleges of W. Bengal, teaching natural and life sciences, mathematics, social sciences and languages. Seven local resource persons and two NCERT resource persons related their expertise on different topics through lectures and discussion with the participants. To give first hand experience about development of modern Indian languages, a visit was made to the Indian Museum on 9.1.91. Two lectures and visits to the galleries in Indian Museum on the evolution of Indian scripts from Brahmi and Khorosthi, proved to be immensely helpful for the participants for enriching their knowledge in such areas.

Selected reading materials and abstracts of lectures by the resource persons have been given in the report. These were supposed to serve as additional information material for the participants for enrichment of their knowledge in such areas.

(2)

The valedictory programme was held on 11.1.91<sup>at</sup> about 2-P.M. Mr. N. Chaturbedi, IAS, Special Secretary (Home), Govt. of West Bengal was the Chief Guest. Prof. P.K. Chowdhury, DPI, was also present as the special guest. Prof. B. Roy, the Field Adviser, welcomed the guests and gave a brief report about the activities performed during the last few days. Prof. J. Mitra of DESM, NCERT, gave his views. The two group reports were read out by the group representatives. Prof. P.K. Chowdhury also gave his remarks on various points in the reports. The Chief Guest, Mr. N. Chaturbedi, distributed the certificates and gave the valedictory address. Dr. V.K. Sunwani of Regional College of Education (Bhubaneswar), gave the vote of thanks.

The Hony. Programme Director, extends his sincere thanks to DPI and his office for suggesting the names of the participants and resource persons. Thanks also go to Mr. N. Chaturbedi, IAS, for giving the valedictory address as the Chief Guest. The Council H.Q. at Delhi had nominated Prof. J. Mitra of DESM. The Regional College of Education (NCERT) at Bhubaneswar had nominated Dr. V.K. Sunwani. Both of them came for the programme to work as resource persons. Thanks go to the Director of NCERT, Dean(A) at the NCERT H.Q. at Delhi and the Principal, R.C.E. (Bhubaneswar) for sending the two officials who had proved to be of immense help. Cordial thanks also go to the local resource persons for their highly useful lectures.

Thanks also go to the participants for their hard labour and tenacious efforts in the preparation of the reports, which have brought to the light many new ideas, hitherto unrecorded.



(3)

Thanks also go to the Office staff of the FA's office for their untiring efforts and sustained work for successfully organising the programme and publication of this report.

Prof. Biswanath Ray  
Field Adviser and  
Hony. Programme Director

January 14, 1991  
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## 1. About the Programme

### 1.1 On Psycholinguistics

The psychological aspects of language teaching and learning have not yet received full scale attention as of basic concern. Language as a vehicle of thought and communication, have been considered as old as the start of human civilization. Going into some of the fundamental considerations, Taraporewala (1978) had mentioned that as science of language, linguistics could be treated as different from philology.

The linguistics is very much general, philology is comparative. "Logos" (or, word) which includes powers of thought and speech, distinguishes man from animals who uses "Alogos". Thus the world of percepts and the world of concepts become different.

A question which emerges naturally is who created language ? The answers could be :

- a) God
- b) Evolution of Man
- c) Connection between sound and sense
  - the bow-wow theory
  - the pooh-pooh theory
  - the ding-dong theory
  - the yo-yo-ho theory

Researchers have since then, attempted to find out the intellectual laws of language and thus giving a beginning to the concept of psycholinguistics. It became important as it involved the mind of the person. The main points are:

(5)

: 4 :

1. the importance of the speaker (a man) having a mind or a "psyche"
2. the psychological factors are variable in state
3. the association of groups and group mind
4. acceptance of a language by a community
5. recourse to analogy
6. contamination : verbal and syntactical
7. human mind disregards rules of grammar (a natural desire)

Psycholinguistics as a subject of study is of recent origin. It is a product of a dyadic interactional process involving language and the person :

LANGUAGE

(Linguistics)

1. grammar
2. style of language
3. developed and developing languages
4. ancient vs. modern languages
5. dialect vs. language

PERSON

(Psyche of the person)

1. self concept
2. value
3. attitude
4. personality
5. self-management

Psycholinguistics, like many other disciplines, has the multi-disciplinary approach. The different branches are :

1. Mathematical psycholinguistics

- 1.1 study of the combinatorial systems, e.g. algebra
- 1.2 performance models of different computer programmes
- 1.3 the unpredictable character of communications, e.g., value concepts.

2. Experimental psycholinguistics

- 2.1 experimental method, situation, task and data
- 2.2 psychological realities of a writer (e.g., use of persons, pronoun, embedding, negation etc.)

3. Developmental psycholinguistics

- 3.1 biological capacities in language learning
- 3.2 why does the child-language change ?
- 3.3 biological and clinical linguistics

4. Anthropological psycholinguistics

- 4.1 the Whorfian hypothesis
- 4.2 cross-cultural study

## 5. Social psycholinguistics

- 5.1 what is the social function of language ?
- 5.2 what other channels of social interaction provide a matrix for verbal communication ?
- 5.3 how does speech reflect socially significant differences between individuals ?
- 5.4 what is the role of language in the socialization of the individual ?

The above points can be related to the personal style dialect, bi-lingualism or multi-lingualism, verbal control, social perception, stylistic variation, word capacity etc.

It is also necessary to understand the language of science as those of natural and life sciences specially as well as that of mathematics. The points which need to be considered here are :

1. In common, English as a language, is being used for communication (lecture or text book) in a classroom to transmit the subject matter or the knowledge to the students by the teachers.
2. It is also true that the kind and content of English or any language, used for teaching literature, social sciences, natural and life sciences and mathematics are not all the same. The sentence patterns, the grammar, the semantics etc. differ from subject to subject, although English may be the link language.
3. The differences can be attributed to the specific set of vocabulary used for the sciences specially, although same word may be used in different subjects but having different meanings. For example, the words motion, force, matrix, environment, space, time etc.

4. while teaching a science subjects specially, a teacher may use a set of vocabulary which may be subject specific, in addition to the ordinary words as link words like, "as such", "however", "but", "thus"...etc.
5. while teaching mathematics, problems are solved through abstraction and structured quantification. It requires mathematical literacy. These can be solved through arithmetic (e.g., time and distance concept, getting LCM and GCF etc.), Algebra (equation and inequation, formulation like  $(a+b)^2$  etc.), geometry (a hypothesis or a theorem), trigonometry and calculus. Each of such areas are expressed in a particular mathematical-linguistics. For example, the concept of proportions in arithmetic, use of signs and symbols in algebra, diagrams in geometry and a premise in calculus - all speak about either discrete or at times, overlapping languages also. In sum, these can again be treated as (1) natural or as "sort language", e.g., the way children utters a word which may not be grammar specific (2) shape or "size language" e.g., geometric figures. These examples can be seen in the nature and natural products also, which is known as "mathematics in nature".

Apart from some of the structural parts, as have been discussed earlier, it is also necessary to know the mental process involved in the problem solving and decision making process. In general, they involve the psycho-sphere of the person. Psycho-sphere is the personal psychological space of the person which he always carries with him to keep him mentally aware, alert and active. Psycho-sphere includes his world of work, recreation, friends, consumer behaviour (actual or window shopping), co-passengers, family etc. The psycho-sphere is an invisible but flexible mental space which either increases or decreases in size according to the psychological expansion of the person. The increase and decrease may be due to the simultaneously varying efforts of pleasure, power and utility principles in life and living.

Further, a 3-dimensional mental process is specifically responsible to guide the psycho-sphere of the person. The dimensions are mental topography (structure) mental dynamics (function) and mental economy (process). These can be briefly stated as :

1. What is the felt need ? (Topography)
2. What the need is going to serve ? (Dynamics)
3. What will be the better way to achieve the goal ? (Economy)

In view of the above, it was felt that the orientation programme could consider the following back-grounds (topography and dynamics) against which language in general and language of science in specific could be useful:

- (i) Classroom teaching for effective communication between the teacher and the student for effective teaching.



- (ii) Text-books for schools and colleges ranging from the primary to the university level.
- (iii) Research papers and books intended for experts and other workers in the same field.
- (iv) Popular science writings for readers with little or no science background.
- (v) Distant teaching materials for correspondence courses.

However, in view of the limited time frame of this programme, it was agreed that only nos. (i) and (ii) will be considered in detail. Remaining others could be taken up by others concerned..

Certain qualities (economy) were also expected to operate in the above mentioned background materials. Four such qualities were identified. They were :

1. Exatitute
2. Expressiveness
3. Comprehensibility
4. Conciseness

Ultimely, all participants were expected to work up <sup>on</sup> the earlier mentioned (i) and (ii) backgrounds and 1 to 4 qualities through a 2 x 4 factorial model of work, keeping the premise of psycholinguistics as the focal point of control. These could be stated as :

- (a) Psycholinguistics for content (classroom teaching) through 4 qualities.
- (b) Psycholinguistics for content (<sup>text book</sup> ~~classroom teaching~~) through 4 qualities.

Note: The lecture notes of Dr. P.K. Chowdhury may be consulted for further details)

Considering these points and may be others as well, the present programme intended to undertake the following assignments:

1. Understanding about the several subject specific uses of English as a language.
2. Prepare sets of words which may be subject specific specially for the science subjects, as the language of that particular science.
3. Prepare a common list of words having similar constructs but bearing relatively different meanings for the subjects.
4. Set the guidelines for the teacher, how he/she should concentrate on using such words as will be good for the subjects of teaching, in relation to those uses by other subject areas.
5. How the above findings will be helpful in writing subject specific text books.
6. Knowledge of psycholinguistics and to relate it with the language of science.

It is proposed that, the participants will form subject based working groups to give reports on the above points from two separate aspects:

1. Teaching of language, science and mathematics as method subjects in B.Ed. Course.
2. Teaching of different science subjects in colleges/ universities.

The working groups will be expected to produce their reports appended by a list of suggested references.

#### REFERENCES

1. Miller, G.A. and David Mc Neil. Psycholinguistics. In Gardner Lindzey and Elliot Aronson (Eds.) The handbook of social psychology (Vol.3, Vol 2nd Edn.), 1969, 666-794.
2. Roy, B. Towards a theory of meaning, Psychol Lingua, 1971, 1(2), 105-122.

3. Russell, B. My present view of the world,  
Encounter , 1959 (Jan.), 6-9.
4. Russell, B. An Inquiry into Meaning and Truth.  
London: Penguin Books Ltd., 1962.
5. Taraporewala, I.J.S. Elements of the Science of  
Language (4th Edn.), Calcutta  
University, 1978.

## 2. Inaugural Programme

The inaugural programme was held at the FA's office on 7-1-91 at about 11 A.M. Earlier the participants started registering their presence from 10 A.M. onwards.

Prof. P.K. Chowdhury, DPI and Ex-officio Secretary (Hr.Education), Govt. of West Bengal, was the Chief Guest to inaugurate the programme. He was extended a cordial welcome by Prof. Biswanath Roy, Field Adviser and introduced the topic of the orientation programme to the Chief Guest. He had also talked about the importance of the topic in view of the NCERT's involvement in textbook writing on various school subjects and promotion of research for qualitative improvement of the teaching-learning process, specially on classroom teaching. He had elaborated about research work in the areas of teacher behaviour, classroom interaction analysis, behaviour change through the use of reinforcements, etc. But the use of language for all such purposes seemed to be of higher importance. As such, it became necessary to study the language used for all purposes, specially the two specified areas of textbook writing and classroom teaching. Certain guidelines were obtained from an earlier orientation programme held in 1988 on psycholinguistics, but on language teaching only. This time it was felt as of high necessity that there should be certain guidelines regarding language of science as well, but studies from the point of view of psycholinguistics.

The Field Adviser, then requested the present resource persons and the participants to introduce themselves to the Chief Guest.

Later in his inaugural address Prof. P K. Chowdhury, expressed his thanks to the Field Adviser for inviting him to inaugurate this programme. The Chief Guest expressed the ~~form~~ need of such a programme on psycholinguistics with special reference to language and science teaching. The Chief Guest inaugurated the programme along with his views on related matters. (The text has been given as a separate reading material at the end). Based upon the views (as key note address), the participants were invited for an open discussion. Several points were revised by them. In brief, those have been mentioned in the next page.

The first point raised was whether the artificial methods of teaching, e.g., computer should be included within the pervue of different methods of teaching. The D.P.I. answered that this method is presently not of much importance in our country.

The second point was on the difficulty in reaching an agreement on scientific terminology to be used in any regional language. Following an extensive discussion, all participants agreed that universality of scientific terminology used in any one regional language will take time to develop and will follow the acceptance of the particular scientific terms by the learned audience.

The third point was whether the textbooks should be as detailed and as easy as the distance study materials. One participant stressed the psychological importance of the teacher in the learning process of the student as compared to the study materials used by the distant learner. Prof. Roy talked about the effective teaching and the communication process loss. Effective teaching, according to him, cannot be measured by the final grades obtained by the students. Depending on the initial intellectual level of the students, an effective teacher would provide motivation in an appropriate manner.

The fourth point was about science and art of teaching and how one can master the science, i.e., understanding, conception and perception involved in teaching. But the art, i.e., pattern, manners and style is personal to each teacher. Another participant mentioned that distance learning is subject learning alone whereas classroom learning involves subject learning as well as personality learning.

The fifth point was about micro-teaching which uses modern devices for teaching and some methods for measurement of effective teaching and involvement of teachers and students in the teaching-learning process.

The sixth point was that two aspects should be taken into consideration while using language in teaching learning process - (a) information based teachable contents, i.e., facts and (b) psychology of students, i.e., behavioural aspects. He also mentioned the need for a balance between the two.

In answer, the D.P.I., Dr. Chowdhury said that the economic factor is a great limitation in preparation of the distance learning study materials, as they have to go into great details. He cited the example of a five hundred page standard textbook which will have to be divided into twenty to twentyfive units for distance learners and thereby became much more expensive. These students do not get the benefit of direct exposure to the teacher and hence have to do without any discussion of their difficulties with him. Therefore, the distance learning study materials are developed in small steps which can be handled by the student on his own without the help of a teacher or a large number of other textbooks or reference materials. Where an educational institution exists with full time teachers and library facilities, these types of study materials instead of standard textbooks will be superfluous. These will also involve wastage of time and effort on the part of the student. A one-to-one discussion is always more helpful than reading a detailed study material. Dr. Chowdhury mentioned and others agreed that science textbooks should be concise and at the same time the authors should keep the background and need of the student in mind. Conciseness should not be

achieved at the cost of the ease of reading and appeal to the student. But then these are the characteristics<sup>of</sup> all good textbooks should have.

In the end, Prof. Biswanath Roy, talked about topography, dynamics and economy involved in any scientific deliberation. He thanked the D.P.I. and all the participants and closed the inaugural session.

Abstract Prepared by

Dr. Manimala Das (née Sarma)  
Deptt. of Physics  
Presidency College  
Calcutta.



3. Daily Routine of Work

7.1.91 (First Day)

10.00 A.M. : Registration  
11.00 A.M. : Inaugural Programme

W E L C O M E : Prof. Biswanath Roy  
Field Adviser, NCERT

About the Programme : -do-

Self introduction by the  
present resource persons and  
participants :

Inauguration and key  
note address by the  
Chief Guest : Prof. P.K. Chowdhury  
DPI and Ex-Officio Secretary  
(Hr.Education), Govt. of W.Bengal.

Open discussion on the  
key note address of the  
Chief Guest :

Vote of thanks : Prof. Biswanath Roy  
Field Adviser, NCERT

Tea :

1.30 P.M. : Lunch Break

2.30 P.M. : Discussions on (1) programme  
outline (2) Write up for the  
programme (3) daily routine  
(4) financial and other  
miscellaneous matters:

Prof. Biswanath Roy  
Prof. J. Mitra  
Dr. V.K. Sunwani

(19).

8.1.91 (Second Day)

- 10.00 A.M. : Lecture by Dr. S. Bhattacharya, D.D.P.I.(Trng.) on "Mathematics as method subject for B.Ed Colleges"
- 11.15 A.M. : Tea Break
- 11.30 A.M. : Lecture by Mr. S. Kar on "Clinical aspects of language teaching"
- 12.30 P.M. (8) : Lunch Break
- 2.00 P.M. : Lecture-cum-discussion by Dr. V.K. Sunwani on "Reading Scientific Texts"
- 3.15 P.M. : Tea Break
- 3.30 P.M. : Formation of two groups for group reports :  
Prof. Biswanath Roy  
Prof. J Mitra  
Prof. V.K. Sunwani

9.1.91 (Third Day)

- 10.00 A.M. : Lecture by Dr. D.K. Chakrabarty, DDPI (Admn.) on "Language of Physics"
- 11.15 A.M. : Tea Break
- 11.30 A.M. : Lecture by Dr. A.K. Das JDSE(P) on "Psycholinguistics and Mathematics Education"

(20)

- 1.30 P.M. : Lunch Break
- 2.00 P.M. : Visit to the Indian Museum  
to  
5.30 P.M.
- (1) Lecture by Dr. S. Chakraborty,  
Education Officer (Indian Museum)  
on "Evolution of the Indian  
Scripts from Brahmi and Khorosthi".
  - (2) Slide show
  - (3) Visit to the scripts gallery  
(described by Dr. S. Bandopadhyaya,  
Guide Lecturer), Indian Museum)

10.1.91 (Fourth Day):

- 10.00 A.M. : Open Session for further  
classification on:
- (i) Social aspect/socio-economic  
aspect
  - (ii) Value education  
  
by Prof. Biswanath Roy
  - (i) Scientific terminology
  - (ii) Concept development through  
scientific terminology
  - (iii) Scientific activities  
  
by : Prof. J. Mitra
  - (i) Relation of psycholinguistics  
to the language of science/  
4 parametres
  - (ii) Language aspect  
  
by : Dr. V.K. Sunwani
- 1.30 P.M. : Lunch Break

(21)

- 16 -

2.00 P.M.

: Group work

'A' group : Teaching of different science subjects in school/college level.

'B' group : Teaching of science and mathematics as method subjects in B.Ed. colleges

Guides : Prof. Biswanath Roy  
Prof. J. Mitra  
Dr. V.K. Sunwari

3.45 P.M.

: Tea-Break

4.00 P.M.

: Lecture-cum-discussions on

(1) Cognitive model for psycholinguistics  
by Prof. J. Mitra

4.30 P.M.

: Lecture-cum-discussion on

(1) Language-some fundamentals

(2) Mono and Bilingualism

by Dr. V.K. Sunwari

11.1.91 (Fifth day)

9.30 A.M.

: Group work (Preparation of the draft reports by Group 'A' and 'B')

Guides: Prof. J. Mitra  
Dr. V.K. Sunwari

1.30 P.M.

: Lunch Break

2.00 P.M.

: Open session and discussion for finalization of two reports

2.30 P.M.

: Valedictory Programme

Welcome : Prof. Biswanath Roy  
Field Adviser, NCERT

Chief Guest : Mr. N. Chaturbedi, I.A.S.  
Special Secretary (Home),  
Government of West Bengal.

Special Guest : Prof. P.K. Chowdhury  
D.P.I. and Ex-officio Secy (Hr.Edu.)  
Govt. of West Bengal.

Reading of the group : Group A: Teaching of different  
reports by the participants science subjects in schools/  
college level.

Group B: Teaching of science and  
mathematics as method subjects  
in B.Ed. course.

Distribution of certificates  
and valedictory address  
by the Chief Guest :

Mr. N. Chaturbedi, IAS.

Resource person's views :  
on the programme/reports

Prof. J. Mitra  
Dr. V.K. Sunwani.

Comments and suggestions  
by the Special Guest :

Prof. P.K. Chowdhury.

Vote of thanks

: Dr. V.K. Sunwani  
Reader in English  
R.C.E. (Bhubaneswar).

Tea :

Payment of TA/DA/  
Local conveyance charges :

5.45 P.M.: Close down of the programme.

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4. List of Participants

1. Dr. (Mrs.) Arunima Mukherjee  
Deptt. of Physics  
Lady Brabourne College  
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2. Mrs. Aparna Banerjee  
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3. Mr. Ashok Roy  
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4. Mr. Banmali Tripathi  
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P.O. & Dt. Malda  
West Bengal.
5. Dr. Dilip Kr. Bhattacharjee  
Deptt. of Physics  
Jadavpur University  
Calcutta - 700032.
6. Mr. Dilip Kr. Paul  
Deptt. of Physics  
Presidency College  
Calcutta - 700073.
7. Dr. Debasish Pal  
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Education, P.O. New Barrackpur  
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8. Mr. Gourdas Halder  
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Tamlukta Mahavidyalaya  
P.O. Tamluk, Dt. Medinipur  
Pin: 721336, West Bengal.
9. Dr. Gopes Kr. Dutta  
Govt. Training College  
P.O. & Dt. Hooghly  
Pin: 712103, West Bengal.
10. Mrs. Geeta Sen Gupta  
Institute of Edn. (P.G.)  
for Women, Chandernagore  
Dt. Hooghly, West Bengal.
11. Mr. Kamal Krishna De  
David Hare Tong College  
25/3, Hallygunga Cir. Rd.,  
Calcutta - 700019.
12. Dr. Hemimala Das (Sarma)  
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Presidency College  
Calcutta - 700073.
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Deptt. of Physics  
Maulana Azad College  
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14. Dr. Narendranath Sinha Roy  
Deptt. of Physics  
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Calcutta - 700064.
15. Dr. Prabab K. Chowdhury  
Govt. Training College  
P.O. & Dt. Hooghly  
West Bengal.
16. Dr. Prabir Kr. Das  
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Vivekananda University  
P.O. Sandikhata  
Dt. Murshidabad, West Bengal.
17. Mrs. Renu Mukherjee  
Institute of Education  
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Alipor, Calcutta-700027.
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Deptt. of Zoology  
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19. Dr. Sibaprasad De  
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Krishnanagar Govt. College  
Dt. Nadi, West Bengal.
21. Mr. Susanta Kr. Dutta  
Govt. Teachers' Trng. College  
P.O. & D. Maida  
West Bengal.
22. Mrs. Sila Mukherjee  
Institute of Education  
for Women, Hastings House  
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23. Mr. Santinoy Chatterjee  
Govt. College of Education  
P.O. & Dt. Burdwan  
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24. Dr. Uday Bankar Roy  
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### 5. List of External Resource Persons

1. Dr. P.K. Chowdhury  
Director of Public Instructions  
and Ex-officio Secretary for  
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7. Dr. Saikat Bandyopadhyay  
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### NCERT Resource Persons

1. Prof. Jagenmay Mitra  
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Bhubaneswar - 751007.



### 6. Formation of Groups and the Group Report

One of the objectives of this programme was to obtain suggestions from the participants in the form of group reports. Keeping this in view, two groups were formed. The groups and their functional objectives were :

Groups	Objectives
1. Teachers teaching in both B.Ed. and general colleges (Group 'A')	1. To consider teaching of different science subjects in schools/college level
2. Teaching in both B.Ed and general colleges (Group 'B')	2. To consider teaching of science and mathematics as method subjects in B.Ed. course

The 24 participants were divided into two groups as per the two group objectives. Adjustments were made as per personal interests of the teachers, information through the lectures, discussions and practical experiences in their respective colleges.

The participants were asked to follow the guidelines given in course of the lectures and their relevance with the objectives. Other points like the learner variable, the language variable, teacher variable, institutional variable etc. were also left for their consideration. It was also suggested that all examples were supposed to be drawn from the known text books taught at different levels.

In view of these guidelines, the groups and their respective members were considered for the concerned reports as follows :

Group - A

- Members :
1. Dr. Mahendra N. Sinha Roy
  2. Mr. Banamali Tripathi
  3. Mr. Dilip Kumar Paul
  4. Dr. Uday Sankar Roy
  5. Dr. Prahir Kr. Ghosh
  6. Mr. Susanta Kr. Dutta
  7. Mr. Santimoy Chatterjee
  8. Mr. Ashok Roy
  9. Dr. Sibaprasad De
  10. Dr. Manimala Das ( Sarmā)
  11. Mr. Kamal Krishna De
  12. Dr. Gopes Kumar Dutta

Introduction

The objective of education is to produce a rational individual with a scientific temperament who can judge other person's opinions on merit. Towards this aim, science education is of paramount importance..

Language is the main vehicle of human thought and communication. The importance of language in Science Teaching can scarcely be overemphasized. The psychological aspects of language in learning and teaching processes have not however receiver much attention. In this report we deal with psycholinguistics in relation to language and science teaching

Psycholinguistics is a hybrid discipline created out of the psychologists' interest in Language and the linguists' interest in Psychology.

The major concerns of Psycholinguistics are the Psychological processes involved in encoding or speaking, in decoding or comprehending and in acquiring language.

Language plays the most vital role in learning of different science subjects, while in communicating information and conception to the learner through class room teaching or through text book.

Without having a minimum competency in language at listening, speaking, reading and writing level neither the teacher will be able to communicate the subject to learner properly, nor the learner will be able to comprehend or to interact with the teachers.

So, Psycholinguistics will have a role in the proper use of language in science to improve teaching learning situation. It is on this aspect we will focus our attention.

## 2. Psycholinguistics & Psycho. L in Sc. Teaching

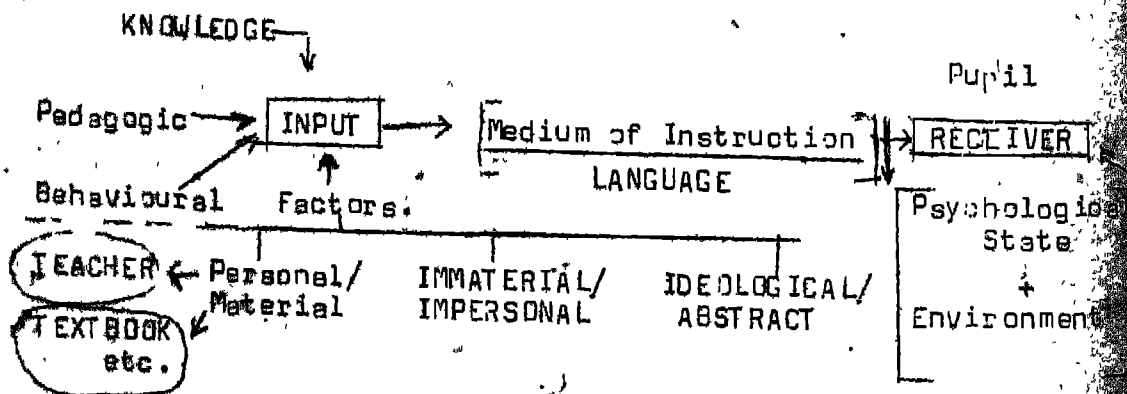
Psycholinguistics, has a definite role on science teaching. So far the medium is concerned, this is done in two forms : (a) verbal/oral form of representation, and (b) written form. These two forms are applied in two aspects the first/former one particularly important for Class-Room teaching whereas the latter one for Text Book Writing.

Psychological aspects of the students are principally measured according to the mental-state of mind of the pupils. It includes the mental stamina, assimilative power, adaptability, power of realisation of the pupils. So, during Sc. teaching, two things are also to be considered along with the above mentioned aspects: i) the Sc. subject, that is taught to the students and ii) the situation/environment, within which the pupil has to learn.

So, the knowledge, is given to the learners as INPUT. From the, psychological part, the 'Input is given on two aspects :

Pedagogic                      Behavioural.

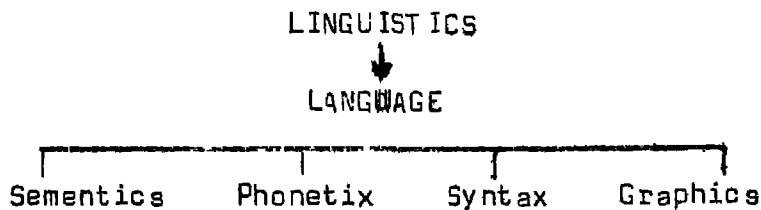
'Medium of instruction here is also very important for transmission of both types of knowledge (Pedagogic & behavioural). Mainly three factors are involved during INPUT e.g. Personal/Material, Impersonal/immaterial factor and ideological/abstract factor. So, receiver has to modify or modulate the psychological state of mind for receiving the particular subject-knowledge, which is transmitted to the receiver (pupil) through LANGUAGE. The following diagram may elucidate the above mentioned aspects.



It is also to be mentioned that this INPUT is also influenced by cultural, aesthetic, social and other factors. These have certainly specific role to change the psychological state of the learners, especially ready to learn science.

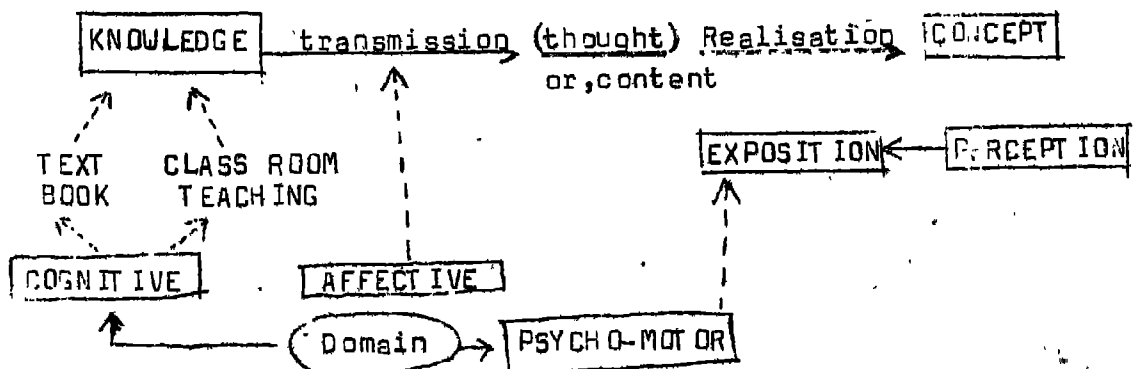
Sometimes, consciously and or sub-consciously the pupils are influenced by the above mentioned factors, beyond the influence of teachers or Text Book.

In this connection it is to mention that the Linguistic part mainly consists of Semantics, Phonetics, Syntax and Graphics.



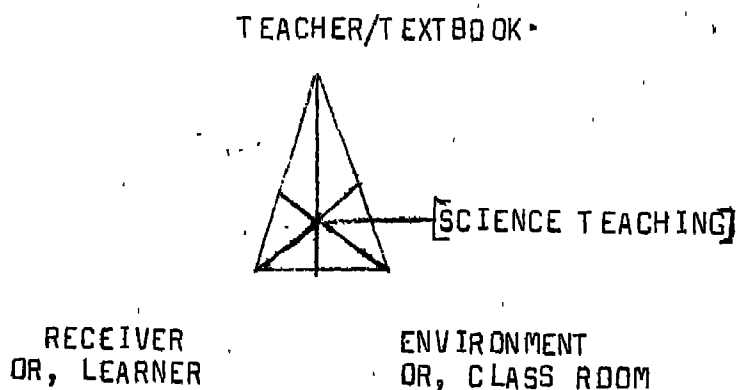
So, whenever the languages would be used either directly by the teacher in teaching learning situation or in the Text Book. The emphasis has to be given on all these four aspects. Among these, the Semantics of the language play the very important and efficient role over others. The effectiveness of the teaching, no doubt, depend on proper transmission

There should have certainly the criteria of development of "concept" that would gradually help in "Perception" and "exposition". The following chart may be helpful to elaborate the approach:

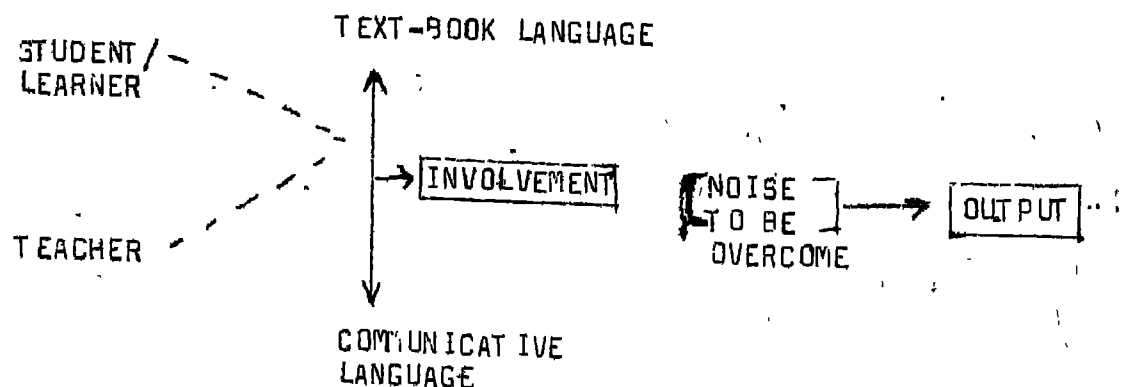


(31)

In relation to science-teaching, however, for the use of language all these three factors are involved.



For the effective teaching of science subject, therefore, involvement of both students and teachers as required. Actually, the things govern us or lead to conformational change are Topography, Dynamics, & Economy. All these points have to be remembered during science subjects teaching.



In this context, it is now clear that language is the main vehicle of communication in all teaching-learning process. In this part we are concerned with special reference to Lg and science Teaching Scientific language has the following features:



- i) exactitude
- ii) expressiveness - insistence on clearly defined terms.
- iii) comprehensibility-appropriateness - fits the level of the target group.
- iv) conciseness : precision in lg use, avoidance of ambiguous statements, suppression of peripheral aspects of word meanings.

When We consider the text-book (+b), the written guide to the subject of a course-instructional tool, the following characteristics should be undertaken into consideration (i.e. the characteristics of a good tb).

- i) structure - orderline of presentation, build simple to complex ideas, concrete to abstract, whole to part, analysis to synthesis (or, synthesis to analysis); Psychological to logical, factual to general etc.
- ii) Coherence - logical development of ideas leading to a "concept", emphasis on "Scientific Method".
- iii) information should be proper, terminologies etc.
- iv) appropriateness: lg. and level of complexity fits the lg. competence and knowledge of the target group.
- v) stimulation; convey the intellectual excitement.

In this context, along with the aforesaid features, the 'art' part of teaching - "the teaching as an art" has also to be encountered for better teaching or for enrichment of teaching-learning process; this includes the style, voice, pronunciation, movement, other personal efforts/habits of the teacher.

But, still the basic question arises - how to communicate an expanding and comprehensive body of knowledge of a modern scientific subject ? A 2 x 4 model may explain it in the following manner: RB CT

E		
Ex		
Com		
Con		

E = Exactitude

Ex = Expressiveness

Com = Comprehensibility

Con = Conciseness.

RB : Textbook

CT : Classroom teaching

However the following points have to be remembered for use of language of science:

1. Similar use should be favoured.  
e.g. 'Temperature' has the same meaning in all science subjects.
2. where as 'Balance', Beam and Pencil have different meanings in different science subjects.
2. . Earlier used words should be taken into consideration as far as possible and practicable. Proper terminology should be used to communicate the concept.

Photo Synthesis - *आकाश-प्रकाश*

Electrolysis - *विद्युत-विघटन*

3. In case of using a word which have different meanings in different subjects, the context to which the meaning of the word is attached, should be classified properly.
4. Specific words should be used
5. The words should have classify
6. The used words should have "Effectiveness" to realise/understand the proper meanings
7. The language to be used should have 'Exactitude', 'Expressiveness', 'Comprehensiveness' and 'Conciseness'
8. Origin may be traced in the case of framing terminology.
9. For concept development the following measures may be taken into consideration for teaching science subjects along with the language used.
  - i) While developing a concept the class and age of the students should be kept in mind. At the first stage concrete idea should be given. The concept may be incomplete but it should convey the meaning correctly at the first stage.

Example . 'Force'

VI & VII level	---	cause of change of direction and/or magnitude of motion
IX level	---	vector concept and line of action, change in state of uniform motion or rest proportional to rate of change of <del>momentum</del>
XI level	—	Relationship to work and frame of reference.

- ii) Proper diagrams - as and when necessary
- iii) Use of audiovisual aids
- iv) Exposition

3. Class Teaching - Classroom teaching is considered in three different sections

A) Primary level (Class I - V)

The basic objective of primary teaching is in essential to generate curiosity among students by transmitting appropriate interesting and scientific informations. For this purpose, it would seem necessary to adopt (a) non-verbal and (b) verbal means along with audio visual techniques and to identify the language skills that students must attain for proper communication at different stages.

By non-verbal techniques we understand that students should be brought into contact with nature for direct and personal experiences to excite their curiosity and consciousness to the surrounding world.

By teaching through verbal means, we understand that the subject should be logically, comprehensively and expressively presented from the aspect of psychological and cognitive-domain. In particular the language of communication must be easily understandable and capable of describing clearly and systematically the necessary ideas to the clients. Native language, considered as the vehicle of transmission of knowledge, should be adopted at the primary level.

In addition to the above mentioned points, the teacher should be frank and open minded in dealing with the students. Socio-economic condition of the students should also be considered. In our country, one of the reasons of failure of teaching at primary level is object poverty which breeds ignorance, inertia and fatalism in the parents. We should remember that poverty and illiteracy go hand in hand.

In essence, the basic stress at the primary level is to educate students through direct experiences/observations, rather than through books. Books which are closed systems should be illustrated with diagrams. Encouragement of drawings and use of audio-visual aids, wherever possible, are essential to enrich the minds of the students. Classroom teaching should also be discussion based.

#### B) Secondary Level (Class VI to X)

It should be noted that the primary objective at this level of teaching is to create a rational approach of the students to outside world. To achieve this purpose, the teaching will be formal in nature and subject-based. The following points are important in this connection.

1. First of all, we have to encourage and/or help the students to concretize their experience at the primary level through systematic reasoning. The development of concept is an essential task of the teacher at this stage. When a new concept is introduced to the clientele, it may be partial but must be correct and concise in form and comprehensive to the students. This partial concept will help to stimulate the curiosity of the students to the next possible development.

To facilitate this process relevant illustrations and experimental demonstrations should be presented, as the concept development process is intricate, slow, helical and hierarchical in nature.

2. It is necessary to undertake, consistently and sincerely, study of language attainments of the students and to identify their language skills to reduce the transmission process loss of knowledge from the teacher to the students.
3. Mode of expression of the students through writing and verbal reasoning should be checked critically at regular intervals.
4. Openness in teaching is also essential to develop a good rapport between the teachers and the students to impart honesty, accountability and the sense of taking responsibility with other social values.
5. To increase scientific vocabulary, students should be exposed to standard international terminologies along with their native terminologies through scientific writings.
6. Mode of teaching will be primarily in native language. The clientele should be exposed to new ideas through illustrations diagrams and mathematical games etc. The development should be monitored seriously with respect to their age. The teachings will be discussion oriented; students will be asked to participate in the discussion.

## C) Examples:

Let us consider a few concrete examples.

Idea - triangle

Primary level

Entering behaviour - straight lines, angles.

Different terms of triangles to be given and students are required to count the number of straight lines in each figure. The term triangle may be introduced here. But the term contains morphemes "tri" and "angle". In English medium attention may be drawn to "three angles" involved. In Bengali medium, the term is "ত্রিভুজ" where it is not necessary to introduce angles.

Secondary Level

Entering behaviour - Place, length segment, different types of angles.

Here a more exact and comprehensive definition can be given. Attention should be drawn to the minimum no. of bounding lines and planar nature of triangles. Triangles are to be broadly divided from the point of view a) magnitudes of angles, b) relative magnitude of different sides.

+ 2 Level

Quantitative relationship among sides and angles in trigonometry can be introduced

Degree Level

Spherical triangles will be introduced

Idea - force

Entering behaviour - Different types of motion e.g.  
motion of a rolling chalk, motion  
of a toy car, motion of a cradle.

These motions can be slowed down, stopped or enhanced with the help of hand. What does hand do there ? It applies force and here the term "force" is introduced. The more extensive and quantitative treatment of force may be given at higher stages. The term force used to Physical Science should be differentiated from political force, social force etc.

Class IX

Entering behaviour - Uniform motion, state of rest.

Discussion may be undertaken with examples from daily life as to how the uniform motion of a body can be changed, how the body at rest may be set at motion. From this, a definition of force may be arrived at. Thus a more exact, comprehensive treatment may be given here.

Classes XI and XII

The definition of force and the establishment of formula for the qualitative measure of force, give exactitude and conciseness to the knowledge. The other characteristics of force e.g. single force, set of forces, external and internal forces, their measuring techniques should also be discussed.



Degree stage

Real force and pseudo force, different origins of forces (electromagnetic, gravitational, nuclear etc.) should be discussed with their applications.

Classroom TeachingExampleDevelopment of concept of cell1st Phase - Class VI

Amoeba বা এই বস্তু - এককোষী - জীবের আকৃতির (shape) ও model আকারে কোষ আকৃতি প্রদর্শিত করার চেষ্টা।

2nd Phase - Class VII

বিভিন্ন ককোষী - জীবের আকৃতির পার্থক্য - কোষের আকার - এবং জীবের মধ্যে আকার স্থানীয় করা।

3rd Phase - Class VIII

Unit (একক) concept (সংরক্ষণ) এর ক্ষেত্রে - typical structure আকৃতি, পরিমাণ প্রদর্শন।

4th Phase - Class IX

- Nephron, Neuron আকার structure - এর মধ্যে কোষ - cell-diversity আকৃতি পরিমাণ প্রদর্শন।

5th Phase - Class X

Cell-division (কোষ বিভাজন) প্রক্রিয়ার মাধ্যমে -

কোষের multiplication আকৃতি পরিমাণ প্রদর্শন।

6th Phase - Class XI

Compound Microscope structure আশাওয়ে  
cell organelle এর, other intra - cellular structure  
অবস্থি concept গুলো,

7th Phase - Class XII others

Electron microoscopic structure এর আশাওয়ে  
cell. অর্ন্তে স্বাক্ষরিত গুলো বসে,

D) HIGHER SECONDARY (+ 2) LEVEL (XI & XII)

During this stage of teaching, the following aspects are important for consideration :

- 1) More precise information with extra-rigour regarding concept development should be traced through language which should be denotative, rather than connotative. New terminology should be used with appropriate historical and epistemological information along with native terminologies so that a student should be capable of interacting confidently.
- 2) To generate independent thinking capability, student should be exposed to new concepts through inductive reasoning and thought examples. In this stage, problem-solving attitude should be encouraged.
- 3) The scientific temperment and for the other person's opinion should be developed in the students.

4) Objective judgement of language-capability, mode of expressions and reasoning-capabilities of the students should be appraised critically.

5) At this stage some books, along with the prescribed texts, containing advanced abstract ideas and rigorous mathematical treatment of earlier concepts should also be available to meet the need of advanced and interested students.

6) Laboratory experiments in relation to class-room teaching should be extensively adopted for effective and meaningful teaching, we must consider the following facts too.

Teachers should be involved in various training programmes on a regular basis to make them useful resource persons, both in lower and advanced levels.

To make school education effective and meaningful and to obtain planned results in terms of time of content, it is essential that the teachers should be serious and sincere. Appropriate economic and social conditions to generate sense of self-respect amongst them. Facilities should be provided to the teachers. Otherwise, the teaching at any level will prove to be ineffective and it will in turn breed looseness in every aspect of society.

7) Finally, to assess the overall success of the school-teaching, restructuring of class teaching and the content of the textbooks are also important. Re-evaluation of the whole process should be made at regular intervals. The restructuring of the formal education system, obtained from the British Administration is also an imperative task.

The interaction between the science teachers and the language teachers should be frequent to avoid compartmentalisation in mental thinking.

Schools should organise annual science exhibition for the benefit of students, teachers and masses.

#### E) Class room use of language in Science Teaching :

The basic features of language of science should be carefully borne in mind. Thus the language used by the teachers in a classroom should be precise and exact. The language should be appropriate to the level of the target group. The "deep structure" of important sentences from the textbook should be discussed in order to bring out clearly its meaning. Etymology of different scientific terms should be discussed. Semantic analysis may also be used to bring out the "bundle of features" in a different scientific terms.

#### 4. Text Book Writing in sciences

Use of scientific language in a text book must have the following features :

1. Exactitude
2. Experiences - insistence on clearly defined terms.
3. Comprehensibility - appropriateness fit the level group.
4. Conciseness - precision in language use, avoidance of ambiguous statement, suppression of peripheral aspects of word meanings.

The text book is a written guide to the subject content of a course and serves as an instructional tool. The characteristic of a good text book may be summarised as follows :

1. Structure : Orderliness of presentation, building of simple to complex ideas and concrete to abstract ideas, factual to logical.
2. Coherence : Logical development of ideas leading to a "Concept", emphasis on "scientific method of reasoning".
3. Clarity : Use of precision in language including clearly defined terms; use of operational definition whenever possible.
4. Information : Emphasize basic principles but include development. However, one must be selective.
5. Appropriateness : Language and level of complexity should fit the language competence and knowledge of the target group.
6. Stimulation : The language of the Text Book should be stimulating to the students.
7. Style : At the primary level the style of the Text Book should be personal. Use of simple sentences with concrete examples. Plenty of illustrations etc. should be there.

At higher level it should gradually be more formal, informative and elucidative.

8. Economy : The main idea behind a text book writing should be centered in three points - Topography (context), Dynamics (How to achieve it) and the Economy which means to achieve our goal in minimum language.

In actual text-book writing it is suggested that at the beginning of a chapter a list of key concepts and new terms to be introduced should be provided. Etymology of scientific terms should be provided in a glossary. In the text the basic definition and major concepts should preferably be boxed. Sub-heading of the major concepts should be provided. At the end of each chapter a summary of the whole chapter must be provided. Pseudo-examples should be avoided. Language of the text book should be in conformity of the social values. Concept of the programme material should be incorporated. It is suggested that during language learning the students should be exposed to "science writing". So in literature courses, textbooks should be written with selections from scientific writing.

### Examples :

Tradinational Book.

### Suggested Form

- 1) Exactitude

```
(for class x)
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১. ২ জনি (এইর একই জনাবী - এই বিবিসি  
 ৩ জনে জন বিবিসি জনাবী - জন বিবিসি  
 ৪ জনে জন বিবিসি জনাবী - জন বিবিসি

- (2) Expressiveness:

(for class VI)

$CO_2$  उत्पन्न होना  
अपघटन-प्रक्रिया

- ০২ প্রদত্ত-১৮৫  
১৮৫০-১৮৫১  
১৮৫১-১৮৫২

3. Coincidence

(for class X)

- বস্তুটির উল্লেখ করা  
 গুরুত্বপূর্ণ জীব  
 ছিল, বিভিন্ন ক্ষেত্রে  
 কখনো-কখনো চাপা পড়ে  
 মাওমাও জেলে গিয়ে  
 কখনো-কখনো বা প্রকৃতির  
 ক্ষেত্রে, এদের জীবনযাত্রা,

- প্রকৃতির বা  
 কখনো-কখনো জীবনের  
 উল্লেখ বা উল্লেখ  
 বিশেষ বা চাপ-  
 কয়েক জীবনযাত্রা,

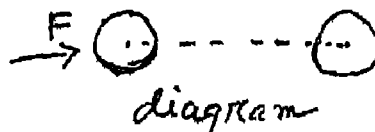
4. Comprehensibility:

(for class X)

এ পদ্ধতিতে পিতা-মাতা  
 দেখানো হয় যে  
 বস্তুটির প্রকৃতি-মুখের দিকে  
 বস্তু জেলে বস্তুটির দিকে

- বস্তুটির দিকে  
 - the phenomena -  
 প্রকৃতি বা  
 পদ্ধতি বা

One example is given below from a textbook of physical science for classes IX and X. The term "work" is introduced idea of doing work and the feeling of tiredness as a result of it. Then comes its definition "কোন বস্তুকে উল্লম্ব বা বস্তুকে প্রাথমিক অবস্থায় রাখা হয়, তবে উল্লম্ব বস্তুকে দ্বারা উল্লম্ব করা হয়"  $W = F \times S$



The scientific situation that no work is done when no displacement is achieved has been emphasised. Then two types of work e.g. when work is done against a force and when work is done by the force are discussed. Now comes the units of work in different systems which are discussed in details.

In the above example, the definition comes after the term is first introduced in the context of our surroundings.

The term "work" is made easily comprehensible to the students with the help of a diagram. At the same time, the magnitude of work in terms of force and displacement is given. Adequate examples are also supplied.

### Summary

In this report we have discussed the role of psycholinguistic in the perspective of language and science teaching. First of all, we have investigated the importance of psycholinguistics in general, and emphasis has been given particularly on the language of science. Four parameters eg. exactitude, comprehensiveness, expressiveness and conciseness have been introduced in relation to the use of language in science. We have discussed the use of language in classroom teaching at three levels - (i) primary, (ii) secondary and (iii) higher secondary. The role of language in writing scientific textbooks at different levels has been discussed. The characteristics good scientific textbooks writing have been elucidated. Concrete suggestions regarding the use of scientific language in classroom teaching and writing textbooks have been given. Examples drawn from different subjects, e.g. physics, chemistry, life-sciences, etc. have been discussed to illustrate the various ideas.

### 5. Appendix Semantics

Sometimes sentences used in the same structural form may carry different meaning in science e.g.



Surface MeaningDeep meaning

I.(a) This is a burning glass ———

The glass causes burning as this glass exists in the form of a converging lens (Here the cause is present in the body)

(b) This is a floating body ———

The body floats itself in a liquid under investigation. (Here the cause is not present in the body itself)

Exactitude

II (a) The earth is heavier than the moon ———

Weight of the earth (having a particular volume) is greater than that of the moon (having particular volume).

(b) Gold is heavier than iron ———

This is nonsense as they have no given volumes. Here the term "denser" is more exact than "heavier".

(The Exactness is one of the main characteristics of scientific terminology. The term energy, pressure, force, field etc. when used in a subject carry different meaning in different contexts. To the context and meaning should be properly related) 1. There are some terminologies used in different science subjects having different prespective. e.g. beam, pencil, normal, capacity, are, polarisation, solution, cell etc. 2. There are some terminologies which have unique meaning in a subject e.g. Gravitation, Adsorption, Cathode, alkali, Calorie, Metal etc.

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### Comprehensibility

- III. All bodies have their natural frequency of vibration.

Here the term "All" have no communication value unless the term "vibrating" is added after the term "all".

### Expressiveness

- IV. Version in a text book ".... It is then taken out and immediately transferred to another metallic vessel containing 0.25.kg. of water at 20°C. The temperature of water rises and attains a steady value of 23°C.

The temperature can't be steady over a long time as there is dissipation of heat from the vessel and the content. So it is the "maximum" temperature with which we are concerned. So we may use "maximum" instead of 'steady'.

### Conciseness

- V. A statement is given below which is not at all concise :

A particle is moving along the circumference of a circle and is describing equal path in equal time during the period of investigation. This type of motion is some what different from the motion of a particle along a line.

(50)

A concise statement may be written as :

Uniform motion in a circular path is different from linear motion.

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Report on  
Teaching of Science & Mathematics as Method  
Subjects in B.Ed Course

Group - B

- Members :
1. Dr. (Mrs.) Arunima Mookherjee
  2. Mrs. Aparna Banerjee
  3. Dr. Dilip Kumar Bhattacharjee
  4. Dr. Debasish Pal
  5. Mr. Gaurdas Halder
  6. Dr. Gopes Kumar Dutta
  7. Mrs. Geeta Sen Gupta
  8. Mrs. Nandita Dutta
  9. Dr. Pranab Krishna Chowdhury
  10. Mrs. Ruby Mukherjee
  11. Dr. (Mrs.) Runu Bhattacharya
  12. Dr. Somnath Ghosh
  13. Mrs. Sila Mukherjee

Noam Chomsky in his book "Syntactic Structure" claimed that a totally different concept of language was needed and thus originated a new discipline viz. Psycholinguistics and a new approach to language viz. "the Generative Transformational Approach". This is a psychological approach focussing the role of mental process in language learning and defining Linguistics as a subdivision of cognitive psychology.

Psycholinguists make a distinction between competence and performance of language. While performance refers to the actual speaking and comprehending processes. Competence refers to speaker's-listener's knowledge of the language. Language competence enables a speaker-listener to construct or code and to understand or decode sentences.

There is another distinction, pointed out by them, between surface and deep structures of sentences. The former is related to what is spoken or heard and the latter conveys the meaning elements and their relationship. This discipline is also attempting at finding out a suitable Model to describe sentence structure and their complexities.

At the Phonological level they are trying to find out why different acoustic signals are often perceived as the same sound.

Researches are also conducted at the Morphological and Syntactic level to find out the effect of ambiguity on words and sentence comprehension; how ambiguities are recognised, analysed and decoded by a listener etc.

At the semantic level the researchers are attempting to define the nature of Meaning and its role in sentence encoding and decoding. There are also attempts to find out the features of Meaning, the possible universal element in features in all languages and their role in the psychological processes like comprehension, memory etc. Another group of psycholinguists hold that the meaning of a sentence is integrated with the information from previously acquired knowledge and the way things are related in the real world.

Here the psycholinguists try to discover the ways in which such meanings are integrated and the psychical processes by which they are influenced and vice versa.

This discipline makes the class-room teachers in general and text book writers in particular, conscious of the fact that language is the most significant aspect of teaching-learning. Hence, while using language we should think of the receiver who decodes.

The terms and the sentences must convey the exact meaning so that the pupils are not put to any confusion. The psychical aspect of language is to be kept in view while using and writing Text-Books and delivering lectures. This discipline makes us alert about selecting right vocabulary for specific subjects and grading them according to the levels of maturity of the learners.

With these brief observations let us now proceed to the detailed discussion relating to Text Book and class-room teaching with special reference to Science and Mathematics.

TEXT BOOK WRITING :-

'Communication is the art of passing on to others the information they need in the form they can understand'. — John Mitchell. For writing a text book one should remember that he/she is communicating with a person who has no scope to discuss any thing with the writer. He/She should consider both the Psychological and linguistic aspects of the reader. Before a text book writer puts his/her pen to paper he/she should keep in his/her mind the following aspects.

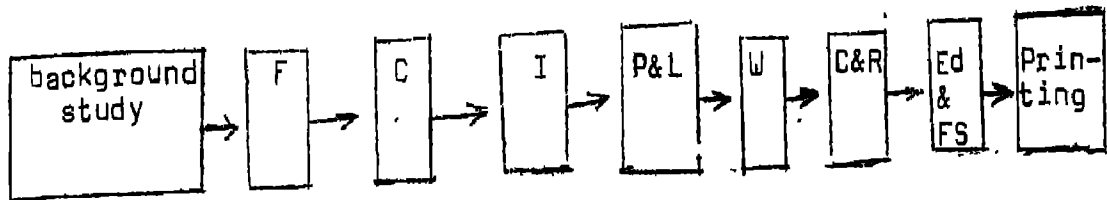
- (1) the reader's minimum educational level in general
- (2) the need of the reader
- (3) the best way to represent the matter for the fulfillment of the need of reader
- (4) language competency of the reader

After considering all the aspects stated, one may start planning for writing the book. The essential steps that should be followed in this connection, particularly for writing text books on science and mathematics as method subjects, are may be listed as follows :-

- a) Fixing up the areas of the content matters to be covered (F)
- b) Classification (C)
- c) Identification of different concepts, terms, definition etc. under each of the classified sections (I)
- d) Planning and layout (P&L)
- e) Writing (W)
- f) Checking and Review (C&R)
- g) Editing and preparation of final scripts (Ed&FS)



Schematically the steps may be shown as :-



Let us now concentrate our attention on the writing (W) part in the series.

The important part of science and mathematics as method subjects in B.Ed. level, is the methodology of teaching the subjects for different groups of pupils. The development of the new branch of knowledge — 'Psycholinguistics' leads us to module the pattern of writing text books in a more meaningful way. The psycholinguistic aspects for writing a text book are to be considered on the basis of the four fundamental principles —

- (i) exactitude (Ext.)
- (ii) expressiveness (Exp.)
- (iii) comprehensibility (Comp.)
- (iv) conciseness (Cons.)

Again S. Freud pointed out that three aspects viz. Topography (T), Dynamics (D) and Economy (E) are significant in case of teaching-learning process. The same idea may also be extended to textbook writing. 'Topography', here refers to the context, 'Dynamics' to the putting of ideas to practice and 'Economy' to the time factor involved in the process. So the four principles Ext., Exp., Comp., and Cons. stated above should be taken into consideration along with these three parameters. The interrelationship of the parameters is illustrated on the right hand side (Fig.-1)

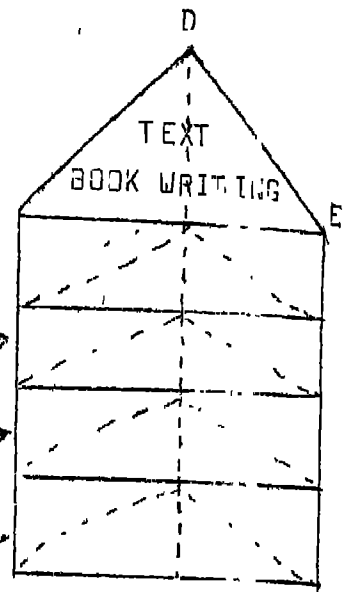


Fig - 1

### CONCEPT PRESENTATION :-

Concepts are developed through different stages as indicated by Piaget. Different levels of pupils may be classified, for our convenience, on the basis of their chronological ages as given below :

Group A	5+ to 10-	age group
Group B	11+ to 15+	age group
Group C	16+ to 17+	age group

Group A is the fundamental stage in respect to the development of a concept. In this stage concepts may be given from concrete matters, but in Group B, the same may be developed by considering concrete materials at the beginning and subsequently through inductive generalisation from particular situations. Beside this generalisation, formation of abstract ideas may be initiated in the Group C level. But the text book writer may follow the maximum - 'from concrete to abstract' for the development of abstract concepts in this stage.

The psychological sequence for the development of a concept of Life Science may be shown as follows :-

For Group A level - Observation of different living and non living objects.

For Group B level - Study of different organs and system of different organisms.

For Group C level - Life processes like Nutrition, respiration, circulation etc. with their bio-chemical reactions  
Eco system - the interaction of various living and non-living components of the ecosystem.

The text book of science and mathematics as method subjects for different levels should spell out different activities and uses of models, charts, real objects, illustrations in a precise and definite manner. For the development of concepts, to make the presentation exact, expressive, comprehensive and concise keeping in view the topography, dynamics and economic aspects of presenting a matter in a textbook, the textbook writer should carefully observe the following :-

- 1) Usual words, phrases or abbreviations should be used so that it may be understood properly (VWPA).

- 2) Long words may be avoided and short words may be used without sacrificing the meaning (USMW).
- 3) Adverbs and adjectives should be reduced without lessening the force of the statement (UAA).
- 4) Short sentences should be used. Normally the number of words in a sentence should not be more than twenty five (USS).

Example -

The following long sentence is detected in a text book.

'When two sets of waves same frequency and same or nearly equal amplitudes travelling through the same medium overlap then it is found that due to superposition they wholly or partly nullify each other at certain places and reinforce each other to produce a greater effect at other times and places'.

We may break the sentence as :-

Two waves of same frequency and same or nearly equal amplitudes will superpose when they overlap. Such a superposition alters the intensity pattern in the space of overlap. Due to this, superposition intensities get wholly or partly nullified at some points. At some other points they get reinforced and produce a greater effect.

- 5) Ambiguity should be avoided in linking up the statements i.e. relative pronouns like 'the', 'it', 'these', 'those', 'they', 'who', 'which', 'whose' etc. should be used carefully so that they may mean clearly for what they refer to. (AAVRP)

Example :-

Let us consider another example from a text.  
 'An impulsive force is a force of very large magnitude but of extremely short duration, which acting on a body produces a finite change of its momentum, displacement of the body during the action of the force being negligible'.

\*Here the pronouns 'which' and 'its' (underlined words) play an ambiguous role. A new learner may confuse to identify the actual words for which they refer to. Short sentences avoiding such ambiguous use of pronouns, may be used here.

- 6) There must not be any lack of arrangement between subject and verb. (ASV)
- 7) Liberal use of necessary pictures, digrams, charts, illustrations etc. should be made for clarification. (LUPDC)
- 8) Illustration (both verbal and non-verbal), diagram etc. referred here should be proper, meaningful and free from ambiguity. (VMID)

Example : -

This example is taken from a text book on mathematics as method subject.

"2টি গরুর দামের সাথে 3টি ছাগলের দাম—  
মোট দাম 975 টাকা। (Rhetoric Algebra)

2টি গরু 3টি ছাগল = 975 টাকা—

(Syncopate Algebra)

$$2x + 3y = 975 \text{ (Symbolic Algebra)"}$$

English version -

Adding the price of 2 cows and 3 goats, it gives Rs.975. (Rhetoric Algebra)

$$2 \text{ cows} + 3 \text{ goats} = \text{Rs.975} \text{ (Syncopate Algebra)}$$

$$2x + 3y = 975 \text{ (Symbolic Algebra)}$$

It seems from the sequence of the statements that  $x$  and  $y$  represent respectively 'গরু' (cow) and 'ছাগল' (goat). Such ambiguous illustration carrying misconcepts should be avoided. Different kind of objects and illustrations for concretisation should be such as may easily be available in the immediate surroundings. Analogical cases may also be discussed in this connection.

- 9) Concepts should not be mislinked. If it is not possible to give the full concept at certain stage, suggestion for the development of partial concept, may be given, stating properly the limitations therein. It may be partial in respect to the level of learner but must not be erroneous. (UPC FC)

Example : -

'Light travels in a straight line '.

This is a statement about the propagation of light. This does not convey the total concept about the propagation of light. It is partial, but it is not wrong. The propagation of light as a wave can be introduced later for getting the total concept about the propagation of light.

Similarly, for giving the concept of 'mass' initially it may be stated that 'mass' is the matter contained in a body. But latter on, it may be developed as a measure of inertia. Subsequently the atomic composition of matter should be developed to relate atomic mass to the amount of matter.

- 10) Unnecessary/superfluous words and phrases should be avoided to convey the proper and concise meaning and to avoid confusion. (ASWP)

Example :-

Let us consider a mathematical problem :

- In a factory,  $\frac{2}{3}$  of the monthly profit is distributed among the workers and  $\frac{1}{6}$  is kept for future. If ₹.2000/- is kept for future, what is the monthly profit of the factory ?
- There are so many unnecessary and super fluous phrases and clauses in the problem. This may create confusion to the learner. Use of the such phrases and clauses should be avoided.

- 11) Development of a concept should be a gradual process, keeping in mind the mental ability and linguistic ability of the learner. (GDC)

The idea or concept of certain phenomenon may be given at an early stage while others cannot be taught prior to a certain level. Spiral form of arrangement may be considered in this respect.

Example : -

' Concept of gene '

At the Group B level, only the manifestation of genetic activity at phenotypic level may be taught with different common examples. In the next level some idea can be given about the localization of genes within a cell when they come to know about cell structure. Only at Group C level they may be given an idea about the allele and the genotype. Chemical aspects of functioning of genes and concept of a gene at molecular level should be taught at still higher level.

- 12) Logical relationship should be developed properly. (DLR)

Example : -

A part of text status as :-

"বিজ্ঞান-এ-অত্যন্ত পরিষ্কার ভাবে প্রকাশিত হয়, একা একাকী পরিজ্ঞানের পর তা ছাড়া দ্বিগুণে তাকান দিবে না।"  
Here the logical relationship is not drawn in a proper way. A writer of text book must be very much careful in this respect.



PRESENTATION OF TERMINOLOGY

The terms and terminologies of science and mathematics may be given in regional language as far as possible along with the corresponding international terms and terminologies in the parenthesis. But one must be careful so that he may avoid ambiguous and/erronious terms.

For example , an author in his text writes as :-

‘বুকের দাববস্ত্রী- অণ্ডগোলের নাম পেটে (belly), পেটে  
নামি (abdomen) অবদুষ্কর করে, পেটের পেটের-  
প্রাচীর বস্তু পরিপাকের মনু ও অন্যান্য-কর-  
কার্য প্রদান করার মনু অবদুষ্কর করে,

Here the underline term does not convey the appropriate meaning. More over, wrong terminology is also used here.

A syntaetic and semantic decomposition and origin of this international terms and terminologies along with a corresponding brief history of the origin and the historical context of the terms/terminologies should be presented in the text books of these method subjects. Let us consider a few terminologies to show the steps of development indicated here.

TermsDevelopment

Centripetal -

The word has a Latin suffix 'peto' meaning 'to seek'. Centripetal means 'seeking the centre'. The term is used in connection with the acceleration towards centre experienced by a body executing motion in a circle.

Compare it with 'Centrifugal' where Latin word 'fugo' is used and that means 'to fly'.

Cephalochordata -

'Cephalo' (comes from Cephalic region) means head region.

This indicates that the animal possesses notochord in their head region.

Cryptogamos -

Crypto - means hidden, gamos - means marriage.

The term indicates the group of plants that do not produce flower for reproduction.

Malaria -

Mal means bad, aria - means air

From this it (term) means the disease caused by bad air - which is, however, proved wrong. But the terminology exists.

Isoclinal folding -

Iso - means equal, clinal - means having an angle. Thus the isoclinal folding is the folding where the limbs produce equal angles with the horizontal plane.

DESCRIPTION AND EXPLANATION : -

Language of description and explanation is very important. They should be presented in a simple, precise and meaningful way. Illustration, schematic representation and diagrams should be used as and when necessary. Reading part of description and explanation should be made minimum but without any aberration from its expected force and meaning. Pseudo examples should be avoided to illustrate, or explain certain concept.

Example : -

In giving an idea of environment, the author of a book describes the environments of a city and of a village as follows :-

‘সহরের পরিবেশ ভবিষ্যৎ চ্যালেঞ্জ, প্রাকৃতিক পরিবেশ-  
মেশন, অর্থনীতি, প্রাকৃতিক সম্পদের মানব সম্পদের ক্ষমতা, জল  
সম্পদ, সহরের কোন মানব সম্পদ সম্পর্কে নিম্নোক্ত-  
প্রশ্ন-নির্দেশনা, সহরে মানব সম্পদের নিম্নোক্ত-  
প্রশ্ন-নির্দেশনা- অল্প কয়েকদিনের মধ্যে  
কোন প্রশ্ন হবে, সহরের মানব সম্পদে কোন মতো  
উঠে আসে শুধু মানব সম্পদে পার্থক্য-  
সহরের জন্য নিম্নোক্ত প্রশ্ন-

সহরের মানব সম্পদে ও নিম্নোক্ত প্রশ্ন-  
বিজ্ঞান পরিচালনা করে, সহরের প্রাকৃতিক-  
উন্নয়ন, মানব সম্পদের প্রশ্ন-  
কল্প-’

From this description the learners will develop certain wrong concept and at the same time this is neither precise nor meaningful.

Certain text books of life science contain illustration with objects that in some cases, inspite of helping the learner to have an actual concept of the item concerned, gives a faulty concept. Such examples can be identified as pseudo examples. Concretely speaking while giving the concept of a 'cell' as the structural and functional unit of the living body, comparison is made with bricks and a building and surprisingly the authors do not hesitate to draw the diagram of bricks and a building whose plaster has been removed partially. Such illustrations leads to pseudoscience. Attempts should be taken to avoid this type of description and illustration to explain certain concept.

Each chapter of the text book should contain at its end a short summary including the broad concepts developed in the chapter, the essential terms and terminologies used and correlated topics. Suggested assignments along with some related problems should also be added at the end of each chapter for the self-evaluation of the learner. In the appendix a short history of the genesis of the terms, concepts etc. introduced/used in the book, should also be given referring the chapter/s in which they are used/introduced.

PSYCHOLINGUISTICS AND CLASS ROOM TEACHING :-

The main objective of teaching is to bring some desirable changes in behaviour among the students. The teacher should acquire the required skills of teaching along with the application of different progressive methods in a proper way for the development of different aspects of content matter. Again it is to be done within a specified period (i.e. during the academic session of the course). For this, it is essential for any teacher to determine the desirable changes in behaviour quite specifically. This leads a teacher to identify the specific objectives in terms of the learner's behaviour. The classification of these changes in behaviour should maintain the sequence of the content matters and should be proportional to the total number of teaching hours available.

..9. .

Let us consider the subject of teaching in the B.Ed level- 'Teaching of the formation of equation' (Simple linear equation of one variable) for elementary stage i.e. class VII.

The changes in behaviour may be listed as :-

At the end of the lesson the learners will be able

- 1) to identify the steps of development to determine the characteristics of a simple equation.
- 2) to compare the characteristics of different methods that may be followed in this connection.
- 3) to choose the suitable method for the development
- 4) to identify the steps of analytic method.
- 5) to use the steps of this method for the formation of equation.
- 6) to form the developing types of questions in this connection.

- 7) to identify the technique of asking specific questions to be asked.
- 8) to form different types of problems for subsequent translation into equation.
- 9) to identify aids that may be used in the particular case.

Addition and alteration of these objectives may be done by the teacher depending on the local situation.

#### PRESENTATION OF THE CONTENT AND LINGUISTICS : -

During the development of subject matter of teacher has no other alternative but to use different types of verbal techniques. For the successful use of any verbal technique special attention should be given to the following psycholinguistic aspects :-

- 1) exactitude
- (2) expressiveness
- 3) comprehensibility
- (4) conciseness.

Choice of precise meaningful words should be strictly adhered to while giving the final inferencial statement. No pseudo-examples should be given in connection with the development of any particular term/concept. If under any circumstance the teacher has to give such example for clarification limitations of the particular example concerned should be explained. He must be very cautious in this respect.

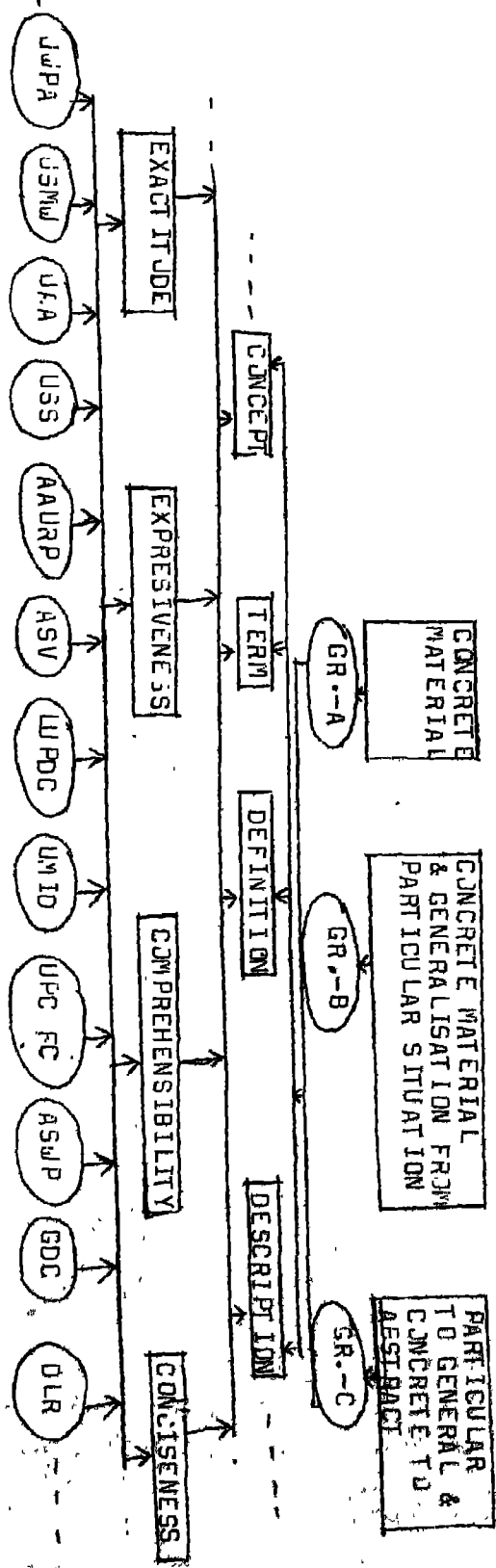
Besides these the following features should also be adhered to.

- 1) Teacher's language of exposition should be such that a proper scientific attitude of the students is developed - a scientific bend of mind is created.
- 2) Science and mathematics as method subjects should not be presented as a closed subject.
- 3) Care should be taken so that the students may not accept anything blindly. They should accept the matter rationally on verification.
- 4) Questions to be asked, particularly for the development of the subject matter, should be thought provoking and of developing type.
- 5) Questions should be asked/invited for searching new ideas - ideas and view points.
- 6) Questions with long answers should normally be avoided in the classroom situation.
- 7) Development of concepts, terms etc. should be made in different short stages maintaining the sequence of the content matter.
- 8) During the development of any scientific and mathematical concepts, illustrations and examples from other branches of science and/mathematics, should be incorporated, so that the students could identify the correlation between the different branches and subjects.
- 9) Psycholinguistic aspects should be considered in all levels of teaching to make the development of content matters precise and meaningful.
- 10) While asking questions, the language of questions should be made simple, nonambiguous and specific.
- 11) Problem solving method should be adopted as far as possible.
- 12) Evaluation on the basis of the expected changes in behaviour, should be made after each stage of development. A comprehensive short evaluation should also be made after the completion of the lesson.

We know that at the lower stage teaching of science is usually done through demonstration so that the pupils can observe the different features of a particular organism or can observe the different steps of an experiment. But at the higher level lecture is sometimes associated with demonstration and laboratory work. Various 'models of teaching' e.g. Inquiry training model (ITM), Concept attainment model (CAM) etc. which are now gradually coming into practices, can be applied for achieving various goals of science teaching. Teacher should organise an open discussion session at the end of each lesson for a short period to elevate the power of rational thinking and scientific organisation of the learner in respect to the subject matter.

Effect of different factors in connection with the development of concepts, terms, definitions, descriptions etc. can be shown schematically in reference to the textbook writing and classroom teaching on science and mathematics as method subjects. The schematic representation is made in the next page (fig.-2)





(71)

Fig. 1. Effect of different factors in connection with concepts, terms, definitions, descriptions etc. (writing and classroom teaching).

## 7. Valedictory Programme

The valedictory programme was held on 11.1.91 at 3.30 P.M. Shri N. Chaturbedi, I.A.S. and Special Secretary (Home) joined the group as the Chief Guest. Dr. P.K. Chowdhury, DPI and Ex-officio Secretary (Hr. Edu.) also joined the group.

The F.A., Prof. B. Roy, extended a hearty welcome to the Chief Guest. He talked about the involvement of Shri Chaturbedi in the activities of the FA's office from his days in the Education secretariat of the Govt. of West Bengal. In fact, the close relationship has always remained alive, as Shri Chaturbedi, himself was in the teaching profession for sometime.

The FA also extended a hearty welcome to Dr. P.K. Chowdhury. Dr. Chowdhury as the Chairman of the State Level Coordination Committee (formerly known as Programme Advisory Committee) of this office, was present in between the programme days to interact with the participants. He had given his ideas in the form of a paper which has been appended in the chapter 8.

The Chief Guest distributed the certificates to the participants and gave his valedictory address. In his address, he had elaborated his experiences as a teacher of physics in higher institutions and levels. The problems related to semantics, elaboration of formulae, mathematical symbols etc. were difficult issues and problems which needed more attention. From such points of views, he had hoped that, the orientation programme has helped the participants to solve and difficult problems in teaching their respective subjects. He also expressed the hope that the contents of the reports, which the participants themselves have prepared, will serve

as guidelines for effective dealing of their subjects, optimization of the mastery level learning of their students and ultimately bring a qualitative improvement in the teaching-learning process.

He thanked the FA for organising such a good programme and inviting him for the valedictory function.

Later, Dr. P.K. Chowdhury, DPI and Ex-officio Secretary (Hr&Education) also addressed the participants. He had hoped that such programmes will be organised again in future for the benefit of other remaining participants. He also said that, the collaboration between NCERT in general and the FA's office at Calcutta in specific and the Education Departments of the Govt. of West Bengal will be strengthened further through such useful programmes. He also hoped that the knowledge gained by the participants will be used by them for their day-to-day classroom teaching.

He also thanked the EA for involving all of them and holding such an useful programme quite successfully.

At the end, Smt. Geeta Sen Gupta, one of the participants, readout her observations (given at the end) in Sanskrit .

The FA whole heartedly thanked all the guests, present resource persons and participants for their close collaboration and cooperation with the FA's office for holding this programme and its successful completion. He also thanked his office staff for their hard and sustained work for holding the programme.

At the end, he invited all for a cup of tea.



## प्रशिक्षणीय किं विनियम

श्रीमान्ते गीता सेन गुप्ता (मुखर्जी)  
 इन्स्टिट्यूट ऑफ एड्युकेशन फॉर  
 इंडिया (प्राजि)  
पन्नाम नगर, दुर्गला

विगत सौमनासरादाख्य शुक्रवाससमय  
 पावत पञ्चद्विजसोया याशतोचना अत्र  
 प्रशिक्षणपर्याये संधारिता सा खलु  
 सर्ववैव वैज्ञानिको स्थापितं मन्ये ।

अत्र खलु उपजोदय विषयः  
 निश्चिन्तितश्चात्पादये या भावा अव-  
 लम्बयेता भवेत्तस्या भवैवैज्ञानिको  
 गिनित्मूमे स्थापयमेव प्रयोजनोयेति  
 प्रतिपाद्यविषयः । सद्येन च स्वतः  
 वक्तुं शक्यते यत् वैज्ञानिकमानसिकता  
 नां लक्ष्यं भवेदिति ।

एतद्विषयालोचनाविषयं २०१ २१  
 गोपित्वयेन हृष्यत् द्विष्यं लिखितम् ।  
 एवं खलु महाविद्यालय विश्वविद्यालय -  
 विद्यालयस्तरे विज्ञानविषय शिक्षा -  
 व्यापारमधिकृत्य अपरेय शिक्षक -  
 शिक्षणमहाविद्यालयेषु मेचड -

विषयत्वेन परिगणित विज्ञान विषयमुप-  
जित्य च । विभागद्वयस्य मध्ये द्वितीय  
विभाग परिग्राह्य सम चिन्तामाला उचिता  
अवश्यमेवाशेन ।

प्राथमिक माध्यमिकोच्चमाध्यमिकान्तर मध्येषु  
एव आलोचन सम्पाद्यमित्पदं मन्वे यतः  
द्वादशवर्षेणोऽप्यवस्था कर्मन्ते वासिनः  
विषयनिर्वाचने अधिकारप्राप्ता भवन्ति ।  
वयःक्रमश्च सप्त पञ्चममवर्षात् दशमवर्षः ।  
एकादशवयसः पञ्चदशं यावत् । ततश्च  
एकादश द्वादशं त्रयोविंश उद्वादशवर्षं यावत्  
परिग्राप्तम् परिगणितभूगोल इतर्य विधा रसायन-  
जैवविद्यादयो वद्वे विज्ञानविषयाः  
उद्वादशवर्षेण सन्निवेशिताः विवरणोऽयम् ।

प्राथमिक पुस्तक प्रणयन काले  
विषयनिर्वाचनविषयकं त्रैलोक्ये शिक्षा  
काले च विषयप्रवृत्त्यनिर्वाचन के-  
रतत् मौलिकविषयद्वयमुपजैव्य विवरणं  
निरूपितं लिखितं पत्रवितम् ।

तत्र च Exactitude अर्थात्  
यथार्थम् परिमितिवोधः सरल भाषया

वौद्यगम्यता (Comprehensibility) संक्षिप्त-  
 (Conciseness) इत्यादि मूल नीति चतुर्विध  
 सन्ति स्व भाषायाः परिभाषकत्वेन विवक्षितम् ।  
 अतः स्व भाषादक्षता सुनिपुणमेवावधिपद्य LSRW  
 अर्थात् अवशाम् । वाचनम् । पठनम् । लिखनञ्च  
 इत्यादीनि भाषादक्षतापरिचायकानि विन्यायानि  
 मूलव्यानीति प्रयोजनीयानि ।

परिगेर्षदं प्रशिक्षण निर्देशक अध्यापक-  
 प्रवर विश्वनाथ शर्मा महोदय समबिधाद्वारेण  
 अपरं ये च मान्यवराः शिक्षाविदो रक्षमान् साधु  
 निर्देशितवन्तः सर्वान् तानेव कुतश्चलनिवेदक-  
 पूर्विक । मदोष वक्तव्यं परिसमापयामि इति ।

॥ भारते मातु भारते ॥





## **8. Selected Reading Materials and Abstracts of Lectures**

The selected reading materials and the general lectures delivered by the resource persons, served as guidelines for the participants. Some of them have been given herewith. The opinion expressed by the authors are their own. It is hoped that the reading materials and the abstracts of the lectures will be useful and interesting for other readers as well.

### **1. Selected Reading Materials**

- 1.1 Russell, B. : My present view of the World.  
Encounter, 1959 (Jan.), 8-9.
- 1.2 De Vito, Joseph A.: Psycholinguistics. Academic American Encyclopedia,  
Vol. 15, pages 591-592, 1989.

### **2. Abstracts of Lectures**

- 2.1 Chowdhury, P.K. : Orientation programme on  
psycholinguistics - the language  
of science.
- 2.2 Sunwani, V.K. : Language-some fundamentals.
- 2.3 Sunwani, V.K. : Mono and bilingualism.
- 2.4 Sunwani, V.K. : Reading scientific texts.
- 2.5 Das, A.K. : Psycholinguistics and  
mathematics education.
- 2.6 Bhattacharya, S. : Proper use of language in the  
teaching of mathematics.

My Present View of the World

- Bertrand Russell

WITTGENSTEIN'S doctrine- influenced me profoundly. I have come to think that on many points I went too far in agreeing with him. Wittgenstein's impact upon me came in two waves the first of these was before the First War; the second was immediately after the War when he sent me the manuscript of his TRACTATUS. His later doctrines, as they appear in his PHILOSOPHICAL INVESTIGATION, have not influenced me at all.

At the beginning of 1914, Wittgenstein gave me a short typescript consisting of notes on various logical points. This together with a large number of conversations, affected my thinking during the war year while he was in the Austrian army and I was therefore, cut off from all contact with him. What I know of his doctrines at this time was derived entirely from unpublished sources. I do not feel sure that, either then or later, the views which I believed myself to have derived from him were in fact his views. He always vehemently repudiated expositions of his doctrines by others, even when these others were ardent disciples.

At the beginning of 1918, I gave a course of lectures in London which were subsequently printed in THE MONIST. I prefaced these lectures by the following acknowledgement of my indebtedness to Wittgenstein. "The following articles are the first two lectures of a course of eight lectures delivered in London in first months of 1918, and are very largely concerned with explaining certain ideas which I learn from my friend and former pupil Ludwig Wittgenstein. I have had no opportunity of showing his views since August 1914 and I do not even know whether he is alive or dead. He has therefore no responsibility for what is said in these lectures beyond that of having originally supplied many of the theories contained in them,.....

It was in these lectures that I first adopted the name "Logical Atomism" to describe my philosophy. But it is not worth while to linger upon this phase, since Wittgenstein's doctrines in 1914 were in an immature stage. What was important was the TRACTATUS, of which Wittgenstein sent me a typescript very soon after the Armistice, while he was still a prisoner at Monte Cassi .....

During the period since 1914 three philosophies have successively dominated the British philosophical world: first that of Wittgenstein's TRACTATUS, second that of the Logical Positivists, and third that of Wittgenstein's PHILOSOPHICAL INVESTIGATIONS. Of these, the first had very considerable influence upon my own thinking, though I do not now think that this influence was wholly good. The second school, that of the Logical Positivists, had my general sympathy though I disagreed with some of its most distinctive doctrines. The third school, which for convenience I shall designate as WII to distinguish it from the doctrines of the TRACTATUS which I shall call WI, remains to me completely unintelligible, its positive doctrines seem to me trivial and its negative doctrines unfounded. I have not found in Wittgenstein's PHILOSOPHICAL INVESTIGATIONS anything that seemed to me interesting and I do not understand the whole school finds important wisdom in its pages.

Psychologically, this is surprising. The earlier Wittgenstein, whom I knew intimately, was a man addicted to passionately intense thinking; profoundly aware of difficult problems of which I like him, felt the importance, and possessed (at least I thought) of true philosophical genius. The later Wittgenstein, in the contrary, seems to have grown tired of serious thinking and to have invented a doctrine which could

make such an activity unnecessary. I do not for one moment believe that the doctrine which has these lazy consequences is true. I realise, however, that I have an overpoweringly strong bias against it, for, if it is true, philosophy is, at best, a slight help to lexicographers, and at worst, an idle tea-table amusement.....

In common with all philosophers before WII, my fundamental aim has been to understand the world as well as may be and to separate what may count as knowledge from what must be rejected as unfounded opinion. But for WII I should not have thought it worth-while to state this aim, which I should have supposed could be taken for granted. But we are now told that it is not the world that we are to try to understand but only sentences, and it is assumed that all sentences account as true except those uttered by philosophers. This, however, is perhaps an overstatement. Adherents of WII are fond of pointing out, as if it were a discovery, that sentences may be interrogative, imperative, or optative, as well as indicative. This, however, does not take us beyond the realm of sentences. There is a curious suggestion, already to be found among some Logical Positivists, that the world of language can be quite divorced from the world of fact. If you mention that a spoken sentence is a physical occurrence consisting of certain movements of matter and that a written sentence consists of marks of one colour on a background of another colour, you will be thought vulgar. You are supposed to forget that the things people say have non-linguistic causes, nonlinguistic effects and that language is just as much a bodily activity as walking or eating. Some Logical Positivists, notably Neurath and Hempel, and Carnap at one time-maintained

explicitly that sentences must not be confronted with fact. They maintain that assertions are to be compared with assertions not with experiences, and that we can never compare reality with prepositions, Hempel maintains that the system which we call true may only be characterised by the historical fact, that it is the system which is actually adopted by mankind, and especially by the scientists of our culture circle. I have criticised this view in AN INQUIRY INTO MEANING AND TRUTH, and will here only repeat the gist of the criticism, which is that what the scientist of your "culture circle" say is a fact and therefore it does not matter what they say but only what other members of your culture circle say they say. It does not seem to have occurred to these authors that when I see a printed statement on a page I am confronted with a sensible fact and that, if they are right, the truth as to what is printed on the page is not to be ascertained by looking at the page but by asking our friends what they say is printed there. We may illustrate Hempel's position by a fable. At a certain period, when his finances were not very flourishing (so the fable avers), he entered a cheap restaurant in Paris. He asked for the menu. He read it, and he ordered beef. All this since entering the restaurant was language. The food came and he took a mouthful. This was confrontation with fact. He summoned the restaurateur replied "Pardon me, but the scientists of my culture circle include sentence 'this is beef, among those that they accept'. Hempel on an own showing would be obliged to accept this with equanimity. This is absurd, as Carnap in due course came to realise. But the adherents of WII go a step further. There had been two views about empirical statements: one that they were justified by conformity to syntactical rules. But the adherents of WII did not bother with any kind of justification and thus secure for language an untrammelled freedom which it has never hitherto enjoyed. The desire to understand the world is, they think, an outdated folly. This is my most fundamental point of disagreement with them.

Psycholinguistics

- Joseph A. DeVito.

Psycholinguistics is a hybrid discipline created out of the psychologist's interest in language and the linguist's interest in psychology. The mutual relevance of PSYCHOLOGY — the study of mental and behavioral operations — and of LINGUISTICS — study of language elements and structure — had long been recognized, but only recently has it achieved the level of an accepted discipline, with its own assumptions, theories, and research methodologies.

The major concerns of psycholinguistics are the psychological processes involved in encoding or speaking, in decoding or comprehending, and in acquiring language. Some claim that the ultimate aim of psycholinguistics is to describe the operation of the mind — or at least of that portion of the brain dealing with language.

BEHAVIORISM

At one stage in its development, Linguistics was restricted to the study of speech behaviour: the only material to be used in analyzing a language was the speech of its people. The linguist would construct a grammar of the language and in a sense formalize the rules that the native speakers were using to fashion their words, phrases, and sentences. Thus linguistics was held to be independent of psychology. The task of the linguist was to analyze behavior. Mental operations were of no importance even if they were important, they were not amenable to scientific study.

Under the behaviourist assumption, the goals of language study were straight forward. One task was to describe the language's sound system -- to describe the individual sounds that occurred in the language and classify them into phonemes, or sounds that are functionally different (--- PHONETICS and PHONOLOGY AND MORPHOLOGY.. A second task was to describe the sentence structure of the language -- how words went together, and which sequences were permissible and which were not like SYNTAX). The role of meaning or SEMANTICS was for the most part limited to such considerations as the changes in word meanings over time or the analysis of morphemes -- the smallest units of speech that carry meaning. In 1957 the psychologist B.F. SKINNER, in his book Verbal Behavior, stated the relation between psychology and language in a much more sophisticated way. Skinner argued that the task of the psychologist of language was two fold: to describe the types of verbal utterances and to explain their occurrence.

For example, a mand (coined on the basis of such terms as command and demand) was an utterance that was controlled by some drive state--an urgent requirement --and that specified a means of satisfying that drive, the behaviour of the listener, or both. Thus the thirsty person would mand water; the request, "Water, please," was controlled by the thirst (drive state) and by the satisfaction of the thirst (reinforcement) on previous occasions. On future occasions the individual would again say, "Water, please", because this request was reinforced in the past. Similarly, a tact (coined on the basis of such terms as contact) was a response that labeled or named an object in the nonverbal world. A person would tact an object, such as water, because in the past such labeling behavior was reinforced, or rewarded.

Thus in Skinner's view language behavior is no different from other learned behavior. The same psychological principles that account for memory, for learning mathematics, or for forgetting also explain language usage and acquisition.

#### THE GENERATIVE - TRANSFORMATIONAL APPROACH

In the same year that Skinner's work appeared, Noam CHOMSKY published a brief book called *Syntactic Structures*; he argued that existing explanations of language did not account for the information that native speakers of a language had at their disposal. A totally different conception of language was needed, and throughout the 1960s and '70s that new approach to language — the generative-transformational approach — has been formulated, expanded, revised, and reformulated.

The position of Chomsky and the generative-transformational grammarians is a mentalistic one and defines linguistics as a subdivision of cognitive psychology. This psychological approach to grammar naturally aroused the interests of psychologists, and their attempts to investigate language behavior with the generative-transformational paradigm might well be considered the beginning of contemporary psycholinguistics.

One of the major distinctions made in psycholinguistics is that between performance and competence. Performance refers to the actual speaking and comprehending processes, which are influenced by such factors as fatigue, attention, and memory. Competence refers to the speaker-listener's knowledge of the language, uninfluenced by any psychological restraints. Language, competence is the knowledge of a language that enables speakers to construct, or encode, and to understand, or decode sentences.

Another essential



distinction made in psycholinguistics is that between deep and surface structures. Basically, the surface structure of a sentence is close to what is spoken and heard; it is similar to the sentence as performed. Deep structure, however, represents the meaning elements and their relationships and is a level of the sentence that is postulated to account for wide variety of language phenomena.

Consider these two sentences: "The boy hit the ball" and "The ball was hit by the boy". The sentences mean essentially the same thing, although on the surface they look quite different. The sentences differ in surface structure but not in deep structure; they differ in form rather than in meaning.

Now consider a third sentence: "They are painting clothes". This sentence has more than one meaning, depending on whether painting is taken as a verb or as an adjective. If painting is a verb, then the sentence means "these people are painting pictures of clothes" or "these people are putting paint on clothes"; but if painting is an adjective, then the sentence means "these clothes are used for painting" or "they are the clothes that painters use". The sentence has two possible deep structures, each corresponding to one of the two possible meanings, but with only one surface structure.

THE SEARCH FOR A MODEL

One of the major problems confronting early psycholinguist research was the assumption that the psychological at theory or model of language competence should be identical with the linguistic model. Early researchers assumed, for instance, that all sentences were formed from the simple, active affirmative, declarative sentence by applying, transformations- that is, linguistic rules by which additions, deletions, substitutions, or permutations are made in sentences. The derivational theory of complexity assumed that there was a one-to-one correspondence between linguistic complexity and psychological complexity. Thus sentences with a large number of transformations would be more difficult to comprehend, to judge as true or false, to recall, or to remember than sentences with fewer transformations.

When empirical evidence accumulated to indicate that this correspondence did not always hold, psycholinguists began to search for a purely psychological model of language behavior. The model would have to take into consideration the data of linguistics and such distinctions as those between performance and competence and between deep and surface structure. The psychological model could not, however, attempt to mirror the model that linguist would be use to describe sentence structure or complexity.

Phonology. At the phonological level, contemporary psycholinguistic research has attempted to confront such issues as the apparent absence of a one-to-one correspondence between the acoustic signal and the perceived linguistic unit. Investigators are trying to learn why different acoustic signals are often perceived as the same sound.

Another issue is the relation between speech perception and speech production. The motor theory postulated that a listener, in perceiving speech, uses essentially the same mechanisms that are used to produce speech. Thus we perceive accurately what someone is saying because we ourselves imitate the sequences the speaker goes through. We know what the speaker is saying because we know what we would be saying with similar movements.

Semantics. At the semantic level, researchers are attempting to define the nature of meaning and its role in sentence encoding and decoding. One assumption is that word meanings are bundles of features, for example, the meaning of wife would consist of such features as human female, and married. Under this assumption, psycholinguistic research at the semantic level is directed at discovering what the features are, the possible universality of the features across all languages, and their role in such psychological processes as recall, comprehension, and memory.

Other psycholinguists make the assumption that meaning is derived from the individual's attempt to fit linguistic information into his or her own cognitive system. Thus the meaning of a sentence is integrated with various other kinds of information - information from other sentences, from previously acquired knowledge, and generally from an understanding of the way things are related in the real world. Under assumption psycholinguists investigate the ways in which such meanings are integrated and the varied psychological processes they influence and by which they are influenced.

Syntax. Most psycholinguistic research has been directed at the syntactic level. Much attention has been given to the role of ambiguity - its effects on sentence comprehension and how ambiguities are recognized, analyzed and decoded by a listener. Paralinguistic phenomena such as rhythm, intonation, and pauses have been investigated to determine their effects on sentence comprehension and their role in sentence production. Other researchers have centered their efforts on the connection between semantics and syntax and the ways in which meaning is related to syntactic processing.

#### THE ACQUISITION OF LANGUAGE

Prior to the development of contemporary psycholinguistics, language learning in the child was explained through a general process of imitation. The child imitated the speech of those around her or him and in this way somehow induced the rules of the language. One of the problems with such an approach, however, was the fact that the child hears numerous ungrammatical sentences yet somehow induces the correct rules of grammar. On the other hand, the child never hears the so-called rules of language and yet learns these quite early and adequately. Further evidence that imitation is not a sufficient explanation of language learning comes from that fact that the child often will hear grammatical utterances, yet will induce rules that are incorrect but are nevertheless regular. For example, the child will hear the past tense of go as went, and the plural of mouse as mice, and yet will say, at least during some period of development, goed and mouses.

According to Chomsky, the child is born with a language-acquisition device that enables him or her to hear speech, analyze it, and derive the rules of the language. Researchers have proposed that the language-acquisition device contains some of the universals of human language such as subject-predicate relationships. What exactly is contained in the device has not been agreed upon. Most psycholinguists today however, seem to assume that some basic information for dealing with language is innate.

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Orientation Programme on Psycholinguistics -the  
Language of Science

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Before anything else, I like to thank the National Council of Educational Research and Training and particularly Prof. Biswanath Roy, the very able representative of N.C.E.R.T. at Calcutta, firstly inviting me to this Orientation Programme and secondly for organising the programme itself. This programme is centred on a rather non-conventional subject. Unlike the more conventional subjects like non-conventional sources of energy, very few seminars or perhaps none have been organised to discuss the language of science. And yet, this is one topic that concerns all learners and teachers of science and all who intend to write on science. The very fact that the language of science has been identified as a subject means that there are certain special expectations from the language one uses or should use in speaking or writing on science. What I shall try to do is to hint at what I feel these expectations are and leave it to the resource persons to corroborate or substantiate their own ideas. Our resource persons and participants have been drawn from able and established teachers and scientists and it is particularly difficult for me to guess what they have stored in their minds. But on the other hand, I feel quite confident that this orientation programme will find its own course rather than confirm the proceedings of previous seminars on the same subjects.

The basic question we want to answer is 'what do we expect the language of science to ?' And we shall try to find the answer with the possible background of varied characteristics in sight. These are :

- (1) Text books for schools and colleges, ranging from the primary to the university level.
- (2) Popular science writing for readers with little or no science background.
- (3) Research papers and books intended for experts and other workers in the same field and
- (4). Distance teaching materials .

There are some qualities, however, that we expect from all science writing and, to some extent, from the language of spoken discussions on science. I shall try to enumerate these realities.

1. Exactitude : We want the expressions to be factually correct. Any **statement** should take all possible exceptions into consideration and must not indulge in over-generalisation.
2. Expressiveness : The language **must** be an adequate tool to describe the situations we are likely to encounter. Before we attempt to write, we have to develop the terminology, either by coining words or by borrowing liberally from other languages. It may also be necessary to supplement the language by mathematical and logical symbols.
3. Comprehensibility : The language must be easily understood by the clientele for whom the writing is intended. For example, it is not enough to write for school students or teach them in the mother tongue. Nor should we ask our students to learn English before they can be given the first lesson in science.



4. Conciseness : The language should convey all the necessary ideas without leading the learner into a jungle of words and expecting him to find his way out by himself.

I would now ask you to look at some examples. I shall read out a few lines that could belong to a high school physics book.

"A bar made of brass has circular cross-section. It hangs from a beam at the ceiling of the laboratory by a vertical steel wire which is clamped at the upper end to the beam and welded at the lower end to the centre of the bar. The bar is uniform and rests in equilibrium".

The description relates to the torsional oscillation of the bar and its moment of inertia, which depends on the position of the bar with respect to the axis of rotation. The description is not exact since the exact orientation of the bar is not stated. It is also not concise and contains details which are irrelevant to the problems. We can state all the essential facts if we write.

"A uniform bar is suspended in a horizontal position by a vertical wire attached to its centre".

I shall read out one more example, this time from a Higher Secondary text-book in Bengali.

"যেহেতু উক্ত বস্তুটির মাঝখানে দৃঢ়তার সাথে  
 যেহেতু এতদ্বারা বস্তুটির বিচলন, উল্লম্ব  
 ও ঘূর্ণন হয়।"

what the author probably had in mind is that the bulb has a thin wall. However the description has failed to carry the concept because it is neither exact nor comprehensible. I am of course happy to say that such examples are not found in plenty in the standard text-books around us, which means that the science writing that we come across has attained some maturity.

I have also mentioned the need for expressiveness of the language of science. The English language is accepted as a very expressive language. In this language you can either scold me, rebuke me, take me to task or if you wish to keep your calm, you may take recourse to a reprove or a reprimand. But even English should try to find some more words to describe polarisation light, polarisation of a dielectric and polarisation in an electrolytic cell even though polarisation in voting pattern may be left untouched. Our own languages have no way of chemical nomenclature and we have freely and quite rightly borrowed from English. In fact some words have been very well assimilated in Bengali. We use them in compound words like 'radio-taranga'. We even use words like (২০/৩৫) derived from the word focus. What I want to stress is the need for coinage and adoption of words in a planned and uniform manner so that we are not short of words and we know what exactly a particular word means.

I shall now return to the distinct types of science writing that I earlier mentioned and briefly examine their specific needs. I begin by quoting from a standard text-book to show how it dispenses information in a business-like manner:

"Number of cells in an organism varies. In some organism, the body is made up of many cells while in others it is made up of single cell. In a human body it is calculated that there are 10 cells on an average. Number of cells increases up to certain period of life and such increase ceases afterwards....."

A popular science writer has to keep the interest of his reader alive. He tries to make his style more attractive and comprehensible, perhaps at the cost of conciseness. Here he writes on heavy water :

কঠিন জল - জল আছে ? হ্যাঁ হুমতো বলবে জল ? জল তো -  
এক বকুলের, মে একটা বেসী জলটা দে বলবে ছুরকুলের -  
সিঁরন জল আর তরী জল। মে আরও বেসী অতিথি দে  
বলবে তিন স্বরনের মোটিমাল জল, ডামারিমাল জল  
আর দ্বিটিমাল জল।"

I read a more striking example of popular science writing -  
"Black holes are cosmic freaks where in time stops, space goes off the edge and matter vanishes into singularity to return transferred, if it ever returned". If you know about black holes, fine. If you don't, the lines merely tell you that black holes are peculiar objects. We would not like a text-book to take us for a ride like this.

In sharp contrast are research papers meant for experts and other research workers. A paper on fibre optics reads :

"It may be observed in conformity with the results in multimode fibres that the effect of ripples on optimum core radius and zero dispersion wavelength is maximum when the ripple frequency is unity". One cannot miss the serious tone and the presupposition that the reader has a fair knowledge of the subject.

I shall conclude by introducing a still different kind of science writing, viz, the study material for distance learners. Such material is produced for students of open schools and open universities and subscribers of correspondence courses. Here the author tries to visualize a face-to-face discussion with his distant student and simulates a conversation by his style of writing. Since the student often has no one to help him with the study, the writing has to be as clear as possible retaining the exactitude of a text book. A good text-book says :

"When a projectile enters a nucleus, it becomes subject to strong internal forces. Its energy is dissipated throughout the nucleus and its direction violently changed. Its identity may be said to become lost".

The same facts may reach the distance learner in a different package, like

" If you shoot a projectile into a nucleus and try to follow its path, you will notice that very strong internal forces start acting on it as soon as it enters the nucleus. It will soon dissipate its initial energy, sharing it with other nucleons and change its direction of motion rather sharply. Very soon you will be at a loss to identify your projectile as its nucleons will become pretty identical with those in the nucleus".

I leave to you to feel the difference of approach.

As I mentioned right in the beginning, I feel certain that our resource persons will have more to say on the language of science. I have not made any attempt to comment on the psychological impact of this language or the science of teaching science. The participants will look at the subject from their own viewpoints and when the proceedings of the orientation programme are summarised, we can hope to, have a fair idea of what the language of science should be.



Language - Some Fundamentals

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- Human language is a system of communicating meanings using the vocal, auditory tract and verbal grammatical symbols.
- Language can be compared with other cultural communicative systems of symbols such as music, clothes, road signs, food etc.
- Human language is developed on an earlier foundation of non-verbal signs and communicative strategies : the para linguistics, involving voice tone, pitch and emphasis, and the kinesic, which includes the whole area of body language.
- Language is creative; we can put together the basic elements of sounds, words, meanings according to the rules of grammar of the language and produce an infinite number of original and appropriate utterances and written sentences.

Since language is man's single most valuable possession let's try to understand its functions -

- 1) Informative - crucial, trivial, true, false-
- 2) Phatic communion - formalities, formulas, politeness
- 3) Expressive - reveal feelings and emotions
- 4) Directive - affects another persons' thought and behaviour not always a command.

In many cases, language combines many of these functions:

### Language and communication

- (1) Informative
- (2) Persuasive
- (3) Expressive
- (4) Directive

#### Verbal

(words)

#### Non Verbal

(everything else)

most powerful means of exchanging information, though not the only one. gestures, facial expressions, voice, signals.

But signals are extremely limited compared to the range of and complexity of human language. Non-verbal communication is pervasive and reinforces verbal communication.

#### Eye-movement

#### Distance

#### Facial expressions

#### Clothes

#### Territory

#### Posture

#### Place language in perspective

How do we learn a language -

Language is non-instinctive. It is culturally transmitted. Language varies from culture to culture, from period to period.



- 1) Exposure to a language is essential for its acquisition.
- 2) Children will learn any language in which they are exposed to regardless of the language spoken by parents.
- 3) Repetition.
- 4) Spoken language is primary, others are derived from it - orally.
- 5) Writing is based on speech, not vice-versa.
- 6) Changes in the written form of a language occur as reflection of changes in the spoken form, the spoken form determines the written form, not the other way.

Ability to learn a language is different from other skills:

- a) It decreases with age
- b) The material is much more complex than of any other thing one learns.
- c) Except in case of severe handicap, every one acquires a language.
- d) Learning conditions are never the best, yet we acquire language.
- e) Motivation is automatically provided.

Language skills -

Listening

Speaking

Reading

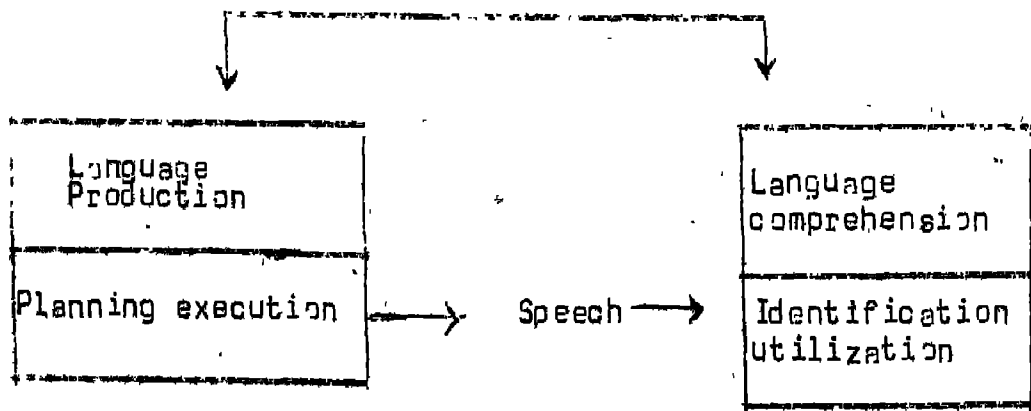
Writing

Linguistics - the scientific study of language.

Psycholinguistics - written the general frame work of interdisciplinary studies concerned with human behaviour and language psycholinguistics refers to the efforts of both linguistic and psychologist to explain whether certain hypotheses about language acquisition and language competence as proposed by contemporary linguistic theories have a real basis in terms of perception, memory, intelligence, etc. This involves the observation of actual linguistic behaviour in laboratory conditions or the close monitoring of communicative situations.

Language behaviour is one of the most characteristic forms of human behaviour.

SENDER	LOAD	RECEIVER
Speaker/writer	Oral/written	Listener/reader



Speakers develop a speech plan with specific intension then execute this plan in the shape of temporally organised speech. Listeners identify this speech stream in a specific way and use this interpretation in a specific way.

### Universal characteristics

- vowels and consonants
- phonemes- distinctive features and distributional characteristics text
- function words and content words sentences
- nominal and verbal constituents
- types of speech acts
- sentences to be combined into texts constituents
- referential use of language words
- phoneme

Language production and comprehension are complex as the creative possibilities of each are infinite.

### Speaking

- S - Setting and scene - physical, time, place, cultural
- P - Participants - face to face, telephone, audience
- E - Ends - outcome and goals
- A - Act sequence - form and content of the message, how and what is said
- K - Key - manner in which the message is conveyed
- I - Instrumentalitics - channels and forms of speech
- N - Norms - interaction & interpretation
- G - Genres - categories, identified the rough linguistic forms employed.

## Mono and Bilingualism

Dr. V.K. Sunwani  
Reader in English  
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Bhubaneswar

- Monolingualism - in the absolute sense by the term, a single monolithic, undifferentiated code system - a totally unrealistic situation
- to say all are bilinguals doesn't get us any where



- Bilingualism is the result of the use of one or more codes - Personal and Social - The use depends of the social valuation of such choices.

High - formal public use - rigid- official language  
low - variable and frequently reduced structure  
limited to spoken channels of communication

- Bilingualism (alone) i.e. without Diglossia  
No society has many speakers who have two  $L_1$ , but every section of the community operates in more than one language in everyday social interaction. Each language has an official status and a clear legal statement of fact.
- Diglossia without Bilingualism  
requires a rigid social system in which group membership is ascribed by birth, not easily lost or

- Diglossia and Bilingualism

More than one nationally recognized code : not only is there a functional division between the codes but an agreement that one is more valued than the other.

The Text Book

Text Book

- students have something in their hands
- reading prepares for writing
- supplements students language experience
- a guide to the teacher
- memory aid to the student
- a permanent record of measure of what has been taught

Therefore in a text book, look for

- a) objectives
- b) curriculum
- c) teaching situation
- d) school organization

Main categories of the checklist should be

objectives and methodology  
structure of the text book  
organisation of teaching

texts, grammar,  
phonetics, morpho  
syntax, vocabulary

didactic conception  
exercises  
motivation of  
learners  
social, situational  
context

communicative  
categories, thematic  
goals, cultural,  
social communication

Basic of a text book will be -

vocabulary

content - scientific, social, cultural, ideological  
lexical

The content analysis should be 1) verifiable

2) systematic

3) quantifiable.

These can be done by

- a) Frequency analysis of situational language use
- b) Frequency analysis of the treatment of social, scientific, cultural aspects
- c) Analysis of the book within the framework of an actual text book selection procedure for a particular institution. Readability of texts to obtain degree of difficulty, frequency of speech acts to determine various aspects of communicative competence.

A text book is prepared according to well defined linguistic objectives. An attempt is made to present various types of language material and scientific material in a well-graded form after careful selection.

- 1) Clearly defined objectives - in terms of the needs and background of the student
- 2) Familiar content - background, people, situation, references
- 3) Structures - properly graded, well selected. Difficult patterns are added to those already prescribed which are further reinforced.
- 4) Vocabulary - new items introduced gradually

- 5) Repetition helps in fixing ideas, patterns and words
- 6) Illustrations - pictures, graphs, diagrams
- 7) Language skills - all the 4 language skills are emphasised
- 8) Spoken language - should have enough scope for spoken language as well as tips for pronunciation.
- 9) Exercises - large number of exercises, covering both areas of language and science
- 10) Teacher's handbook gives detailed methodology for every lesson
- 11) Audio visual aids, laboratory equipment and work books.





Reading Scientific Texts

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Scientific and technical texts contain a great deal of information, most of which consists of facts. Readers of such texts must be able not only to extract information but also to understand the material fully. Hence careful and thorough reading is required.

Students can be helped to read comprehensively if teachers equip with tools that will enable them to cope with texts on different subjects. Some of the problems are -

- 1) interpreting the meaning of words
- 2) comprehending sentences
- 3) comprehending paragraphs
- 4) interpreting illustrations

Vocabulary interpretation techniques

Students are unable to follow a text because they do not know the meanings of words. We can help them by

- 1) Check the meaning of the word in the dictionary.

It gives the students an accurate meaning for the word. The dictionary can be used effectively, so that they can choose the correct meaning of an unfamiliar word.

- 2) Interpret the meaning of the word by word analysis.

Break down words into small elements. Stem prefix, suffix. The meanings of commonly used stems and affixes and then interpreting the meaning of each element it is possible to obtain a meaning for the entire word.

3) Guess the meaning of a word from the context by using context clues.

The clues may be word or words, phrases or punctuation marks around the unfamiliar words. Context clues are of different kinds.

- a) Definition - A term may be formally defined or the sentence may contain sufficient explanation to make the meaning apparent.
- b) Experience - The students' experiences or imagination makes the meaning of a word clear.
- c) Contrast - When two terms are contrasted, if the meaning of one of them is unknown, this helps to clarify or explain the other term.
- d) Inference - Sufficient clues are available to make an educated guess at the meaning.

#### Sentence - Comprehension techniques

It sometimes happens that a student every word in a sentence and yet is unable to comprehend what the sentence means, specially when it is long and complicated. Therefore the teacher can help the studnets by practicing.

##### 1. Sentence Analysis

Whenever a student does not understand a sentence he should analyze it by breaking it down into parts. In order to do this properly by the student should be taught to recognise various sentence patterns. Then a complicated sentence can be analysed and understood by looking for the verb, the subject, the object and lastly, the modifier.

## 2. Recognition of Punctuation clues

Punctuation makes help to convey the writers' ideas to the reader. If the students are aware of the meaning and usage of these marks, they can use this knowledge in determining the meanings of words and sentences.

## 3. Recognition of Reference terms

Science writers use reference terms frequently in order to avoid repeating the same word over and over. These reference terms include personal pronouns it, they, he etc; demonstrative pronouns this, that, these those; relative pronouns which, that, who, whom and nouns the method, the process, the technique.

If these terms are recognized immediately by the students it will lead to greater comprehension since they know each reference term points to.

## 4. Recognition of Signal Words

A signal word is a word or phrase that functions as a connector in a sentence, between sentences, or between paragraphs. Students should be taught to pay attention to signal words and to try to interpret what they signify or indicate.

The most familiar and frequently used signal words are -

- a) Addition - and as well as, and also, besides, in addition to, apart from, moreover, furthermore.
- b) Cause - effect relationship - hence, accordingly, due to, as a result, so, therefore, thus, as a consequence, so that, because of, owing to.

- c) Condition - if, when unless, provided.
- d) Contrast - but, through, still yet, despite.
- e) Comparison- like, unlike, in the same way, similiary.
- f) Doubt or Hypothesis - possibly, prehaps, probably.
- g) Emphasis - really, above all, in effect, in particular, especially.
- h) Sequence or order of events - in the beginning, first, later, then, next, eventualls.
- i) Examples and Restatements - for example, that is, namely, such as.

#### Paragraph analysis

Sometimes a student understands all the sentences in the reading material but still does not understand what it is saying as a whole. This is because he does not know how the material is organised. Students should be taught to recognize the organisation and presentation of information in the passage. They can be taught to :

- a) find the topic
  - b) find the main idea
  - c) find major supporting details
  - d) find minor supporting details
- a) Find the topic - students discover what the paragraph is about - i.e., what the topic is. The topic must be precise - not too specific, not too general.
- b) Find the main idea - after finding the topic, the student in to look for the main idea, which can be a definition, a classification, a purpose or an explanation of the topic. The student should find the main idea from the topic sentnece or from the requisite information from the paragraph.

c) Find major supporting details

Students should be trained to find the major supporting details that modify the main idea. They should also know the functions of these details, which are of many types -

- details that define
- details that clarify
- details that explain
- details that compare/contrast
- details that show cause-effect relationship
- details that restate

d) Find minor supporting details

As above students are trained to locate major details that support major details.

4) Interpretation of illustrations

Most science text books are accompanied by illustrations to help the reader better understand the ideas presented e.g. explanations or descriptions of processes, measurements, and presentations of facts. Line drawings, graphs, tables, photographs, block diagrams are generally used. Students have learned about these illustration from experience, experiment or other subjects. They can be provided with exercises to practice interpreting illustrations quickly and accurately by means of scanning.



## Psycholinguistics and Mathematics Education

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### 1. Introduction:

In recent years one witnesses a tremendous surge of interest in studies and researches on a variety of aspects of language. The upsurge of liberation on linguistics with its many ramifications such as psycholinguistics, sociolinguistics, etc. provide a strong evidence to this activity. Of all such stands of linguistics, mathematical linguistics stands out to be remarkably different in the sense that it is here one finds an interaction of two kinds of languages - the non-mathematical (verbal for instance) language being scanned, mathematized and couched in strictly mathematical language consisting of symbols, signs, notations, etc. The consideration of language has become exceedingly important on account of its immediate relevance to problems of instruction and expression in mathematics.

### Psycholinguistics :

Prior to psycholinguistic revolution inspired by Noam Chomsky in the 1950s the two major influences on psychologists studying language behaviour were information theory and learning theory. According to the technical definition of information introduced by Shannon's theory of telecommunications (Shannon and Weaver, 1949), what is

important is not the content of a message but the probability that it would be transmitted. This means that the output of language users can be looked at as a set of message sequences in which each word has a definite probability of coming. The implication is that it is these probabilities that control individual speakers' outputs and their ability to process language. Experiments carried out by George Miller (1954) and others showed that varying the probabilities of words and letters occurring in different contexts has a significant effect on subjects' language performance.

From the point of view of learning theory, verbal responses are thought of as a sub-class of responses in general. Consequently, they can be explained by the general laws governing the establishment of connections between stimuli and responses, although there is disagreement about how complicated the stimulus-response connection need to be in the case of complex behaviour such as problem solving, thinking and language. The simplest account is Skinner's (1957), claiming that verbal responses are directly attached to stimuli without any need for intervening variables such as meaning, ideas or grammatical rules. Mainly associated with Osgood (Osgood, Suci and Tannenbaum, (1957) is mediation learning theory, which treats meanings as symbolic mediation processes. These are unobservable meaning responses to words, which represent only a part of the overall response that would have been made to the object, and in turn stimulate appropriate responses to the word. Osgood's theory in its original version concentrated on measurement of meaning responses to individual words, with here emphasis placed on the problem of how word meanings are combined to produce meaningful statements. As with information theory, the stimulus-response approach is concerned with the probability that a particular verbal response will occur, in this case due to a previous history of conditioning.



During the early stages of the use of the word 'psycholinguistics' in the early 1950s interest in linguistic analysis co-existed quite happily with information theory and learning theory approaches to language behaviour. This state of tripartite co-existence between information theory, learning theory and linguistic analysis lasted until 1960 when the work of the linguist Noam Chomsky were first introduced to the psychologists. The major change as far as psychology is concerned is that Chomsky's linguistic theory makes explicit a definition of language which appears to rule out the possibility of linguistic analysis continuing to co-exist with information theory and learning theory accounts of response probabilities and conditioned word meanings. The arguments used by Chomsky and his supporters were designed to show, first, that learning theory is in principle unable to account for the speaker's ability to use language and second, that in any case, acquisition of stimulus response probabilities would be a wildly uneconomical explanation of language learning. On the first count the crucial point is Chomsky's demonstration that the number of grammatical sentences is potentially infinite, since it is always possible for a speaker to produce some new combination of words not spoken before. Obviously it is theoretically impossible to calculate the probability of words occurring together in a new combination on the basis of previous frequencies of occurrence.

Chomsky's generative theory lies in its central emphasis on the creative aspect of the language user's ability to produce novel sentences he has never uttered or heard before. By making it the avowed aim of transformational grammar to provide a set of rules for

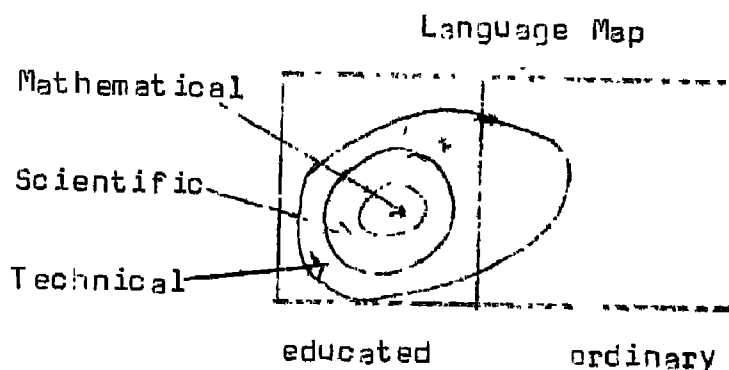
generating the infinite number of possible sentences in a language, Chomsky appeared to be offering an exact correlate of the rules which enable a native speaker to produce all the sentences of his language. To recreate the sense of excitement aroused by this interpretation of generative grammar, one only has to imagine the discovery of an equivalent programme of formal rules to mimic other complex human process, such as problem solving or memorization. In these areas psychologists can only look at the indirect effect of subjects' presumed rule strategies; in the case of language they can turn to Chomsky's generative linguistics for a complete account of the rule operations necessary for sentence production.

### 3. Linguistics - Mathematics Interaction :

1960

It is only in early/that the interaction between language development and the growth of mathematical understanding started engaging attention of researchers, although almost a decade ago the great Piaget realised the importance of mathematical ability vis-a-vis language development. But is only in mid - 1970s that studies and researches in this direction have received a greater spurt than ever before. This has often been attributed to lack of linguistic medium capable of communicating mathematical ideas and concepts, particularly in developing countries of Africa, Asia, Latin America etc. In fact, the concern can be said to be feebly discernible at the 2nd, International Congress of Mathematical Education held at Exeter in 1972. This paved the way for a regional activity on the theme at the Nairobi Symposium (1974).

This can be foreseen for many purposes, the forerunner of studies and researches in this direction. The language issue in the teaching of Science and Mathematics was again taken up a year later (1975) in a Seminar held at Aora in the same continent. Bent Christiansen gave a good account of this issue in the ICMI Regional Conference held at Bharevari, India in the same year (1975). Next to this the issue was focussed at a greater depth in the 3rd International Congress on Mathematical Education at Karlsruhe in 1976. C.P. Ormell posed there the following 'language map':



Although one can raise various questions about the subsets, one can possibly force the mathematical language, in some sense, a proper subset of educated language. Nevertheless, this map does indicate about existence of some aspects of mathematics for which there are specific and special linguistic terms.

The annotated bibliography on the topic, 'Language and Mathematical Education' by Austin and Howson refers to any problems encountered at the mathematics language interface; for example, the pattern and order of established

mathematical symbols which run counter to the child's vernacular or even the transition from the informal restricted language of the child to the precise formal language of mathematics, etc. Later in the International Seminar on Mathematical Education held at in 1979 it was felt that there is also a need for considering mathematics education from linguistic as well as cultural points of view. It was also reckoned that vocabulary and syntax are equally crucial in a mathematical context.

There after this issue has been taken up in different regional seminars, symposia etc. and at international level at the 4th, 5th and 6th International Congress on Mathematical Education, held in 1980, 1984 and 1988 at Gervely, Melade and Bucharest.

#### • Analysis of the Present Problem

Capability of a language in conveying the vigour and logic of mathematics depend largely on the degree of its development. A 'developed' language may be defined 'as one that is used freely in the functions that language serves in the society in question.' Thus a language may be considered as best in respect of ordinary conversation and other social interactions between its speakers but may be found not very suitable for mathematical purposes. In this respect the language may be considered as 'undeveloped' or under 'developed'. In certain studies it has been reflected that even English, which is considered as one of the most developed languages, has been found under developed

for certain aspects of mathematical education. This necessitates development of 'mathematical register' in any language chosen as the medium of instruction.

Mathematical education of today needs more linguistic capability than what was necessary in the past. To meet this requirement there is an effort to increase mathematical vocabulary in every language of the world. Apart from the variability of the new vocabulary in the same language one has to keep in mind that mathematical register does not mean the development of new vocabulary only. The register of a language is composed of words, specific meanings attached to words, phrases and structures along with particular emphasis attached them. In this sense, a mathematical register is constituted of the meanings that belong to the language of mathematics and all that a language must express if it is used for mathematical purposes. Thus we may conclude by saying that since the modern demand of verbalisation in mathematical education is quite high, most of our Indian languages, which have so far not been exposed to modern mathematical terminology, must have now registers of mathematics. Again development of a new mathematical register is inseparably connected with basic linguistic elements like semantics, syntax, morphology and vocabulary and different ways of combination of these basic units of a language. Hence there is a need for investigating how best to exploit semantic resources of the language of instruction for the teaching of mathematics.

## 5. Concluding Remarks

From the point of view of psycholinguistics only this much may be mentioned here that there exists wide disagreement between renowned psycholinguists like Piaget, Chomsky, Vygotsky, Bruner, etc. about the structure underlying human intellectual performance. They look at language and thought from different points of view. As mathematical learning, mathematical discovery and the communication of mathematical ideas are basically thought processes, different roles that language play in these are extremely important for our purpose. From the works of the above named psycholinguists it may be concluded that mathematical concepts originate in concrete experience and language may help in the process of building concepts, through discussion and instruction in activities to be undertaken in the class room which will provide the necessary experience. Hence psycholinguistics has a dominant role in the field of mathematical education.

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Proper use of language in the teaching  
of Mathematics

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Publication of "Syntactic Structures" by Chomsky, in 1957 ushered in a revolution in the descriptive study of Language. Various models of descriptive grammar have been put forward. Psycholinguistics is concerned with experimental verification of such models through psychological tests.

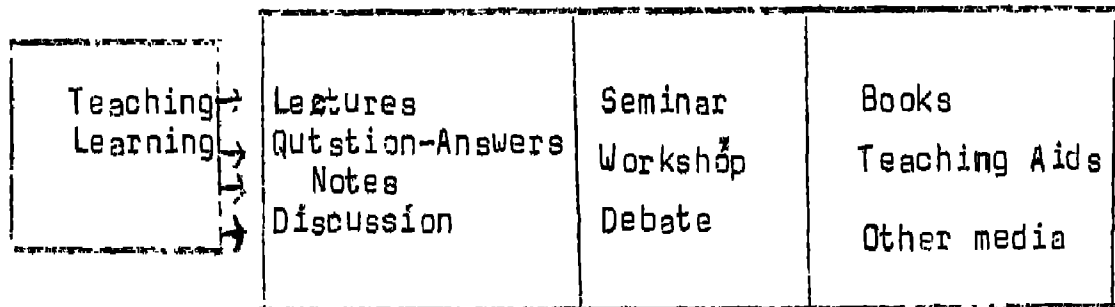
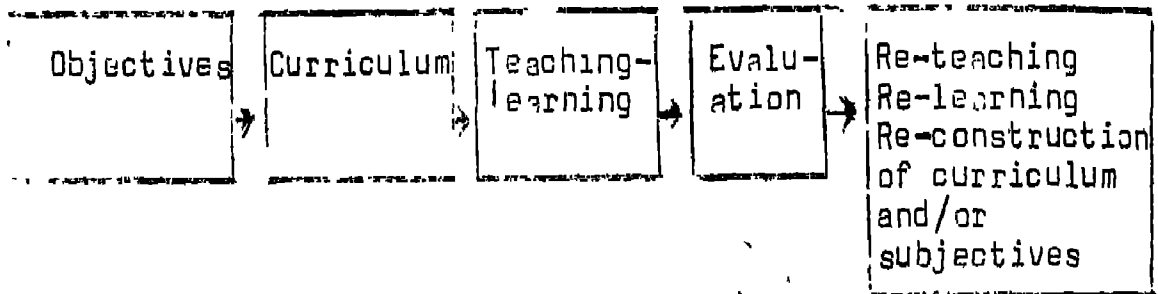
The present discussion, however, deals with the precise and effective use of language in teaching Mathematics in order to facilitate learning with maximum economy in time and efforts.

Language is the medium through which the contents of a subject are communicated to students. Language is essential for writing books, for classroom teaching, for questioning and for writing answers.

Every subject has its own language which can carry the knowledge, understanding and skill associated with it. A subject has its own terminology, terms which are characteristic to the subject - terms which express definite knowledge, understanding and skill connected with the subject. The same term may be used in two subjects with different meanings. Thus it is very much necessary to keep in mind both the term and the subject to avoid any confusion and misunderstanding that may arise.

However, one term/verbal element may have different impacts on different students w.r.t. a subject. The same term/verbal element may create different domains in cognitive space in different students, thereby causing differences in their knowledge, understanding, application and skill.

Language is important in each of the following :



We know that "every teacher is a teacher of the mother-tongue". As such it is very important to note that irrelevant and important use of language may lead to basic conceptual errors - which happens to be true for both actual teaching and writing of books. Corrections, precision and lucidity must be maintained in the use of language.

Some examples from Mathematics are given below :

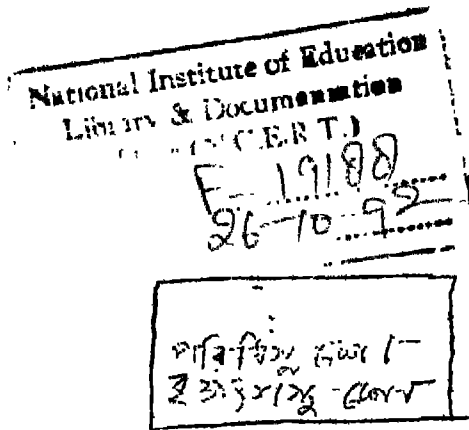
### উদাহরণ (উদাহরণ)

- (i) বাস্তবিক জীবনে প্রায়শই দেখা যায় যে, ৬০ বছরের একটি উচ্চশিক্ষিত ব্যক্তি যিনি যৌনসম্মত অধিকার অর্জন করেছেন - নিকটবর্তী স্থানে বসবাস করে, ৬০-৭০-৮০-এ পৌঁছানোর আগে থেকেই পিতৃহীন বা মৃত্যুবরণ করেছেন।
- (ii) এক ক্রিকেটার তার অধিকারিত ৩/৪ অংশ-এর একটি টেস্টে বাকী অংশ-এ দুইবার দিলেও প্রায় অর্ধশতাব্দীর জন্য ৬০০০০-এর বেশি তার অধিকারিত অংশের জন্য রক্ত?
- (iii) তিনটি বৈজ্ঞানিক দ্বারা প্রমাণিত হয়েছে যে

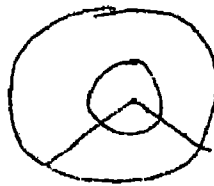
অনুমান-দ্রুতি :  $A \cap B$  একটি নির্দিষ্ট স্থান  
 $(A \cap B)^c = A^c \cap B^c$  নয় বরং ?

নবম শতাব্দী : Trigonometry-তে  
 $\sin \theta = \frac{\text{নিকটবর্তী}}{\text{অনুমান-দ্রুতি}}$   
 অর্থাৎ নিকটবর্তী : অনুমান-দ্রুতি

হুমায়ুন কামালী : জ্যোতিষ্ম জোনের গুণ



৭মার্চ ১৯৯২ সালের উপর ভিত্তি করে  
জ্যোতিষ্ম জোনের গুণ - জ্যোতিষ্ম  
মাত্রা করলে - যে জোনা  
উপস্থাপন করা হবে জ্যোতিষ্ম -  
জোনা বলা হয় -

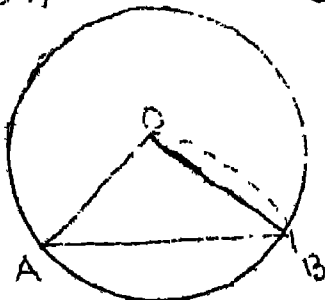


Concept of Radlex

জ্যোতিষ্ম জোনা জিলা উপস্থাপন করে জ্যোতিষ্ম  
জোনা - জ্যোতিষ্ম জোনা জ্যোতিষ্ম জোনা  
জোনা জ্যোতিষ্ম জোনা জ্যোতিষ্ম জোনা  
জ্যোতিষ্ম জোনা

জ্যোতিষ্ম জোনা জিলা উপস্থাপন করে জ্যোতিষ্ম জোনা

$$OA = AB = OB$$



জ্যোতিষ্ম জোনা জিলা উপস্থাপন করে জ্যোতিষ্ম জোনা  
=  $\angle AOB = 60^\circ$  এটি জ্যোতিষ্ম জোনা  
জ্যোতিষ্ম জোনা

